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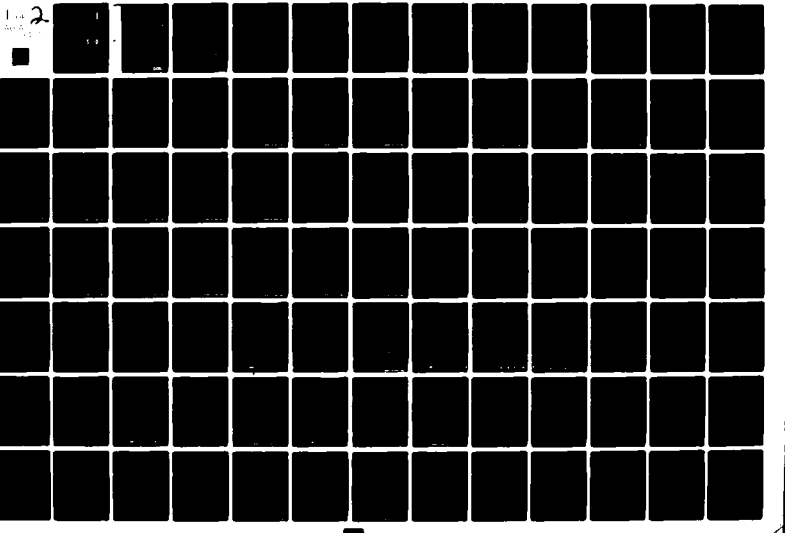

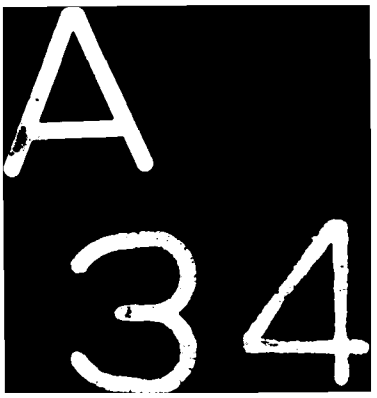
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GEOTECHNICAL EVALUATION

VOLUME II
ARIZONA
VERIFICATION STUDIES, FY 79
GEOTECHNICAL DATA
BUTLER CDP, ARIZONA

PREPARED FOR

SPACE AND MISSILE SYSTEMS ORGANIZATION (SAMSO)

NORTON AIR FORCE BASE, CALIFORNIA

FUGRO NATIONAL, INC.
Consulting Engineers and Geologists

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Geologic stations were established at selected locations throughout the CDP at which detailed descriptions of surficial basinfill deposits or rock were recorded.

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SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

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Prepared by:

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Long Beach, California 90807

15 November 1979

VOLUME II
GEOTECHNICAL DATA, BUTLER CDP

TABLE OF CONTENTS

DRAWINGS IN POCKET

SECTION 1.0

GEOLOGIC STATION DATA

EXPLANATIONS OF GEOLOGIC STATION DATA

Geologic stations were established at selected locations throughout the CDP at which detailed descriptions of surficial basin-fill deposits or rock were recorded. Locations of all geologic stations are shown in Drawing 1, Activity Location Map. All data taken on surficial basin-fill units at these stations are listed in Table 1-1 and an explanation of the column headings in the table is given below. At stations where rock descriptions were made, only geologic unit designations are listed. A general explanation of all geologic unit symbols used in Verification Studies is included at the end of this section.

Column Heading Table 1-1	Explanation
Station Number	Geologic stations are numbered sequentially. Where more than one geologic field team worked in a CDP, stations made by each team are differentiated with a letter (A, B, or C) following the station number.
Geologic Unit	Generic geologic unit only, i.e. the grain-size designation (f, s, g, c) is omitted from surficial basin-fill units. The letter B in the unit designation indicates a buried deposit not exposed at the surface.
MPS MM	Average maximum particle size in millimeters.
Grain Size (%B, %C, %G, %S, %F)	Estimated particle size distribution using the Unified Soil Classification System. Percentages of boulders (%B) and cobbles (%C) are based on the entire deposit, whereas percentages of gravel (%G), sand (%S) and fines (%F) are taken only on the fraction composed of particles less than 3 inches (76 mm) in diameter.
USCS	Soil class according to the Unified Soil Classification System.

Munsell Color — Soil color based on Munsell Soil Color Chart.

Source Rock Types(s) — Rock types of coarse clasts listed in order of abundance.

* Physical Properties — Data listed in columns 6 through 15 address specific soil properties. These are listed below in parentheses following the column heading number and are also listed at the bottom of Table 1-1. Data are coded with each numerical entry referring to a specific soil condition as listed below.

6	(Grain Shape)	1) Angular, 2) Subangular, 3) Subrounded, 4) Rounded, 5) Well rounded
7	(Moisture Content)	1) Dry, 2) Moist, 3) Wet
8	(Plasticity of Fines)	1) None, 2) Low, 3) Medium, 4) High
9	(Consistency)	Coarse grained: 1) Very Loose, 2) Loose, 3) Medium Dense, 4) Dense, 5) Very Dense, Fine grained: 1)Soft, 2) Firm, 3) Stiff, 4) Hard
10	(Structure)	1) Stratified Tabular, 2) Stratified Other (lensed, cross bedded, discontinuous beds), 3) Nonstratified
11	(Cementation Induration)	1) None, 2) Weak, 3) Moderate, 4) Strong
12	(Depth to Cemented Layers)	Depth to layer (in centimeters) exhibiting cementation induration described in Column 11 (above)
13	(Weathering of clasts)	1) Fresh, 2) Slight, 3) Moderate, 4) Very
14	(Soil Profile Development)	1) None (A-C profile), 2) Poor (incipient B-horizon), 3) Well (prominant B-horizon)
15	(Caliche Development)	1) Stage I, 2) Stage II, 3) Stage III, 4) Stage IV, 5) None

Drainage

DP (M)	Average depth of drainages (in meters)
WD (M)	Average width of drainages (in meters)
Slope (%)	Average slope of ground surface (in percent grade)
Sample	Number of samples taken

GENERALIZED GEOLOGIC UNITS

Explanation

Surficial Basin-fill Units

A1 Younger Fluvial Deposits - Major modern stream channel and flood-plain deposits.

A2 Older Fluvial Deposits - Older incised stream channel and flood-plain deposits in elevated terraces bordering major modern drainages.

A3 Eolian Deposits - Wind-blown deposits of sand occurring as either thin sheets (A3s) or dunes (A3d).

A4 Playa and Lacustrine Deposits - Deposits occurring in modern, active playas (A4) or in either inactive playas or older lake beds and abandoned shorelines associated with extinct lakes (A4o).

A5 Alluvial Fan Deposits - Alluvial deposits consisting of debris flow and water-laid alluvium near mountain fronts, grading into predominantly water-laid alluvium deposited in shifting distributary channels near the basin center. Younger (A5y), intermediate (A5i), and older (A5o) alluvial fans are differentiated by surface soil development, terrain conditions, and present depositional/erosional environment.

Grain sizes of these deposits (except A3 deposits, which are exclusively sandy) are indicated by a single letter (f, s, g, or c) following the geologic unit symbol. These letters indicate the predominant grain size and range of soil types according to the Unified Soil Classification System:

f - fine-grained (ML, CL, MH, CH)

s - sands (SP, SW, SM, SC)

g - gravels (GP, GW, GM, GC)

c - coarse grained with greater than 30 percent boulders and cobbles (generally GP, GW, GM, GC)

ROCK UNITS

I Igneous (undifferentiated). Rocks formed by solidification of a molten or partially molten mass.

- I1 Intrusive - Plutonic rocks formed by solidification of molten material beneath the surface (e.g., granite, granodiorite, diorite, gabbro).
- I2 Extrusive (intermediate and acidic) - Volcanic rocks of intermediate and acidic compositon formed by solidification of molten material at or near the surface, (e.g., rhyolite, latite, dacite, andesite).
- I3 Extrusive (basic) - Volcanic rocks of basic composition, generally formed by solidification of molten materials at or near the surface (e.g., basalt).
- I4 Extrusive (pyroclistic) - Rocks formed by accumulation of volcanic ejecta (e.g., ash, tuff, welded tuff, agglomerate).

S Sedimentary (undifferentiated) - Rocks formed by accumulation of clastic solids, organic solids and/or chemically precipitated minerals.

- S1 Arenaceous and/or Siliceous Rocks - Composed of sand size particles (e.g., sandstone, orthoquartzite) or of cryptocrystalline silica (e.g., opal, chert).
- S2 Carbonate Rocks - Composed predominantly of calcium carbonate detritus or chemical precipitates (e.g., limestone, dolomite, chalk).
- S3 Argillaceous Rocks - Composed of clay and silt-sized particles (e.g., siltstone, shale, claystone).
- S4 Evaporite Rocks - Precipitated from solution as a result of evaporation (e.g., halite, gypsum, anhydrite, sylvite).
- S5 Coarse Clastic Rocks - Composed of gravel sized or larger clasts (e.g., conglomerate, breccia).

M Metamorphic (undifferentiated) - Rocks formed through recrystallization in the solid state of preexisting rocks by heat and pressure (e.g., gneiss, schist, hornfels, metaquartzite).

SOIL DESCRIPTION | TERRAIN

STATION NUMBER*	GEOL UNIT	MPS	GRAIN SIZE % GR	% SA	% SF	USCS	MUNSELL COLOR	SOURCE ROCK TYPE(S)	*PHYSICAL PROPERTIES 6	7	8	9	10	11	12	13	14	15	DRAINAGE (FPM)	(MM/H)	SLOPE (%)	SAMPLE
ALPG01A	A5Y	070	00	07	20	060	020	SM	10.0YR4/4	I2	P							1	5	.0	000	00	0
ALPG01C	A3S	020	00	00	07	385	015	SM	07.5YR5/6									1	1	.0	000	00	1
ALPG02A	A5I	140	00	02	20	060	020	SM	05.0YR4/6	M	I2	S1											
ALPG02P	A5I	050			15	065	020	SP	07.5YR5/6	M	I2												
ALPG03A	A5I	140	00	07	35	045	020	SM	07.5YR5/4	M													
ALPG03B	A1	100	00	07	25	055	020	SM	07.5YR5/6	M													
ALPG04A	A2	175	00	07	24	070	005	SM	10.0YR4/4	I1	I2	M	S1										
ALPG04B	A3S	030	00	00	01	074	020	SM	07.5YR4/6	I2	M												
ALPG05A	A5I	190	00	07	25	070	C05	SP-SM	07.5YR5/6	M	S1												
ALPG05P	A5I	100		02	50	030	020	SM	07.5YR5/6	M													
ALPG06A	A2	180	00	07	20	065	015	SM	07.5YR7/6	M	S1												
ALPG06P	A3S	007			01	079	020	SM	07.5YR5/4	M	I2	S2											
ALPG07A	A5Y	140	00	07	30	050	020	SM	07.5YR4/4	I2	M												
ALPG07B	A5I	040	00	01	07	060	040	SC	07.5YR5/6	M	I2												
ALPG08A	A5Y	090	00	07	15	065	020	SM	07.5YR4/4	M													
ALPG08B	A5I	080				060	040	SC	07.5YR5/6	I2	M												
ALPG09A	A5I	530	07	10	40	035	015	SM	10.0YR4/4	M													
ALPG09B	A3S	040	00	00	02	083	015	SM	07.5YR5/6	M	I2												
ALPG10A	A5I	200	00	05	15	060	020	SM	07.5YR5/4	M													
ALPG10B	A5I	150		05	55	035	010	GP-GM	07.5YR5/6	M	I2												
ALPG11A	A5I	210	07	10	50	030	010	GM-GP		M													
ALPG11B	A5I	130		03	55	035	010	GP-GM	07.5YR5/6	M													
ALPG12A	A5Y	210	00	05	40	050	005	SP-SM	10.0YR4/4	M													
ALPG12B	A5I	150	07	05	55	030	015	GM	07.5YR5/6	M	I2												
ALPG13A	A5Y	080	00	07	50	045	005	GM-GF	10.0YR4/4	I2	M												
ALPG13D	A1	100	00	00	05	092	003	SP	10.0YR5/4	I2	M	I1											
ALPG14A	A5Y	040	00	00	10	065	025	SM	10.0YR4/4	M													
ALPG14B	A5I	180	00	07	05	080	015	SM	07.5YR5/6	M	I2	I1											
ALPG15A	M																						
ALPG15M	A2	073	00	07	35	050	015	SM		M	S2	I2											
ALPG16A	A5I	090	00	07	10	075	015	SM	10.0YR4/4	M													
ALPG16B	A1	033	00	00	07	085	015	SM	07.5YR5/6														
ALPG17A	A5I	260	00	07	35	045	020	SM	07.5YR4/6	I2	M												
ALPG17B	A2	060	00	00	70	020	010	GP-GM		M	S2	I2											
ALPG18A	A3	100	00	07	20	075	C05	SP-SM	10.0YR4/3	I2	M												
ALPG18B	A2	083	00	00	60	020	020	GM	10.5YR6/4	M	I2	S2											
ALPG19A	A5I	080	00	07	30	045	025	SC	07.5YR4/4	M	I2												
ALPG19B	A2	060	00	00	07	090	010	GP-SM	10.0YR6/4	M	I2	S2											
ALPG20A	A5Y	070	00	07	40	040	020	SM	10.0YR4/4	M													
ALPG20B	A3D	025	00	00	00	085	015	SM	07.5YR5/6	M	I2	S2											
ALPG21A	A5I	120	07	05	25	045	025	SC	10.0YR4/6	M													
ALPG21B	A5I	050	00	07	15	060	020	SM	07.5YR5/6	M	I2												
ALPG22A	A5I	100	00	05	55	030	010	GM-GP		M	I2												
ALPG22M	A5I	125	CC	10	65	020	015	GM		M	I2	I1											
ALPG23A	A5I	110	00	07	40	040	020	SC	07.5YR4/6	M													
ALPG23B	A5I	125	00	10	30	055	015	SM	07.5YR5/6	I2	M	S2											
ALPG24A	A5D	350	05	10	60	020	005	GM-GP		M	I1												
ALPG24B	A5I																						
ALPG25A	A5Y	120	00	05	40	030	025	SM	07.5YR4/4	M	I2												
ALPG25B	A3S	023	00	00	07	080	020	SM	07.5YR6/6														
ALPG26A	A5I	140	00	05	50	025	020	GC	07.5YR4/6	I1													
ALPG26B	A3S	018	00	00	00	085	015	SM	07.5YR6/6														
ALPG27A	A5I	200	07	05	50	025	020	GP		I1	P												
ALPG27B	A5I	036	00	90	07	065	C35	SC	07.5YR5/6	M	I2												
ALPG28A	A5I	090	00	07	10	065	025	SP	10.0YR4/6	I1													
ALPG28B	A2	057	00	00	05	075	020	SM	07.5YR6/6	M	S2												
ALPG29A	A5I	100	00	07	15	065	020	SM-SC	07.5YR4/6	I1													
ALPG29B	A5I	040	00	00	07	060	020	SP	07.5YR5/6	M	I2												
ALPG30A	A5I	200	00	07	55	020	025	GP		I2	I1												
ALPG30C	A2	078	00	00	15	070	015	SM	07.5YR6/6	M	I2	S2											
ALPG31A	A5Y	050	00	00	05	070	025	SM	07.5YR4/4	I1	M												
ALPG31P	A3D	020	00	00	00	090	010	SP-SM	07.5YR5/6														
ALPG32A	A5Y	050	00	00	35	060	010	SP-SC	07.5YR4/4	I2	M												
ALPG32B	A5I	062	00	00	12	068	020	SM	07.5YR5/6	M	I2	S2											
ALPG33A	A5I	120	00	05	60	015	020	GM		I1													
ALPG33P	A5I	070	00	00	05	075	020	SP	07.5YR5/6	M	I2	S2											
ALPG34A	A4O	300	07	10	55	025	010	GP-GM		I1	M												
ALPG34B	A5I	130	00	01	35	040	025	SM	07.5YR5/6	I2	M												
ALPG35A	A5I	090	00	07	30	060	C10	SP-SM	10.0YR4/6	M													
ALPG35P	A5I	100	07	10	55	035	010	GM-GP		I2	M	S2											
ALPG36A	A5C	200	07	05	50	030	015	GP-GC		M													
ALPG36B	A5I	100	07	05	70	020	010	GP-GM		M	I2												
ALPG37A	A5I	040	00	00	05	075	020	SM	07.5YR4/6	M													
ALPG37E	A5I	300	07	10	55	030	015	GM		M	I2												
ALPG38A	A5I	080	00	07	60	030	010	GP-GM		M	I1												
ALPG38B	A5I	060	00	00	00	045	015	SP	10.0YR7/4	M													
ALPG39A	A5I	080	00	00	10	075	015	SC	07.5YR4/6	M													
ALPG39B	A5I	100	00	10	70	015	015	GM	07.5YR5/6	I2	I1	M											
ALPG40A	A5Y	090	00	07	20	060	020	SM	07.5YR4/4	M	I2												
ALPG40B	A5I	140	07	10	55	025	020	GC	07.5YR5/6	I2	M	S2	I1										
ALPG41A	A1	240	07	05	60	025	010	GP-GM		M													
ALPG41B	A1	350	07	10	55	040	005	GP		I2	I1	S2											
ALPG42A	A5I	150	00	07	55	035	010	GM-GF		M	I1												
ALPG42B	A5I	176	06	05	60	020	020	GC		I1													
ALPG43A	A5O	200	03	10	65	015	007	GM-GP		I3	I2												
ALPG43R	A5I	300	07	10	60	020	020	GC		I1													
ALPG44B	A5I	250	07	05	60	020	020	GP		I2	I1	M	S2										

*PHYSICAL PROPERTIES :
6 - GRAIN SHAPE
7 - MOISTURE CONTENT
8 - PLASTICITY FINES
9 - CONSISTENCY
10 - STRUCTURE
11 - CEMENTATION-INDURATION
12 - DEPTH TO CEMENTED LAYER(CM)
13 - WEATHERING OF CLASTS
14 - SOIL PROFILE DEVELOPMENT
15 - CALICHE DEVELOPMENT

GEOLOGIC STATION DATA
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE 1-1

FUGRO NATIONAL, INC.

SECTION 2.0

GROUND WATER DATA

EXPLANATIONS OF GROUND-WATER DATA

Existing ground-water data in Butler CDP were collected from all available sources. These data were updated where possible from measurements taken during Fugro field operations, and all data are shown in Table 2-1. Locations of water wells and boreholes in which water-level measurements were available are shown in Drawing 1. Well numbers listed in Column 1 (Table 2-1) refer to well locations in Drawing 1. Actual well numbers giving location according to the Bureau of Land Management Land Survey System are shown in Column 2.

Water levels generally refer to the static ground-water table in the unconfined basin-fill aquifer. Perched conditions or levels in artesian aquifers are noted where known.

WELL NO.	WELL LOCATION NUMBER*	ELEVATION OF GROUND SURFACE - FEET (METERS) ABOVE M.S.L.	DEPTH OF WELL - FEET (METERS)	WATER LEVEL			REFERENCES**/ REMARKS
				DEPTH BELOW GROUND SURFACE - FEET (METERS)	DATE MEASURED	ELEVATION - FEET (METERS) ABOVE M.S.L.	
W1	(B-9-11) 30dcb	2380 (725)	65 (20)	36 (11)	1975	2344 (714)	3,4
W2	(B-8-12) 6aca	2010 (613)	-	735 (224)	-	1275 (389)	5
W3	(B-8-12) 23bcd	3300 (1006)	830 (253)	740 (226)	1975	2560 (730)	4,5
W4	(B-8-13) 4ddd	1790 (546)	1000 (305)	530 (162)	1974	1260 (384)	4,5
W5	(B-8-13) 20ccc	1730 (527)	1350 (411)	-	-	-	2
W6	(B-8-14) 20dab	1522 (464)	545 (166)	244 (74)	1975	1278 (390)	4,5
W7	(B-8-14) 23daa	1620 (494)	730 (222)	340 (104)	1976	1280 (390)	4
W8	(B-8-14) 23dda	1618 (493)	1000 (305)	343 (104)	1977	1275 (389)	4,5
W9	(B-8-14) 25cba	1645 (501)	1500 (457)	368 (112)	1975	1277 (389)	4,5
W10	(B-7-9) 2ddc	1425 (434)	552 (168)	158 (48)	1978	1267 (386)	4,5
W11	(B-7-15) 9ddd	1365 (416)	145 (44)	95 (29)	1975	1270 (387)	4,5
W12	(B-7-15) 10aac	1395 (425)	680 (207)	-	-	-	2
W13	(B-7-15) 11ddd	1444 (440)	1002 (305)	170 (52)	1975	1274 (388)	4,5
W14	(B-7-15) 12dad	1490 (454)	680 (207)	216 (66)	1975	1274 (388)	4
W15	(B-7-15) 21bab	1345 (410)	202 (62)	77 (23)	1967	1268 (386)	1,4

*Gila and Salt River Baseline and Meridian

**References

1) Briggs (1969)
2) U.S. Bureau of Reclamation (1978)
3) U.S. Geological Survey (1975)
4) U.S. Geological Survey (1978)
5) Wilkins and Webb (1976)

NOTE: All wells tap unconfined alluvial aquifers except where noted. Where published data are lacking or inaccurate, ground surface elevations are taken from topographic maps.

GROUND WATER DATA
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE 2-1

UGRO NATIONAL, INC.

AFV-18

SECTION 3.0

SEISMIC REFRACTION DATA

EXPLANATIONS OF SEISMIC REFRACTION DATA

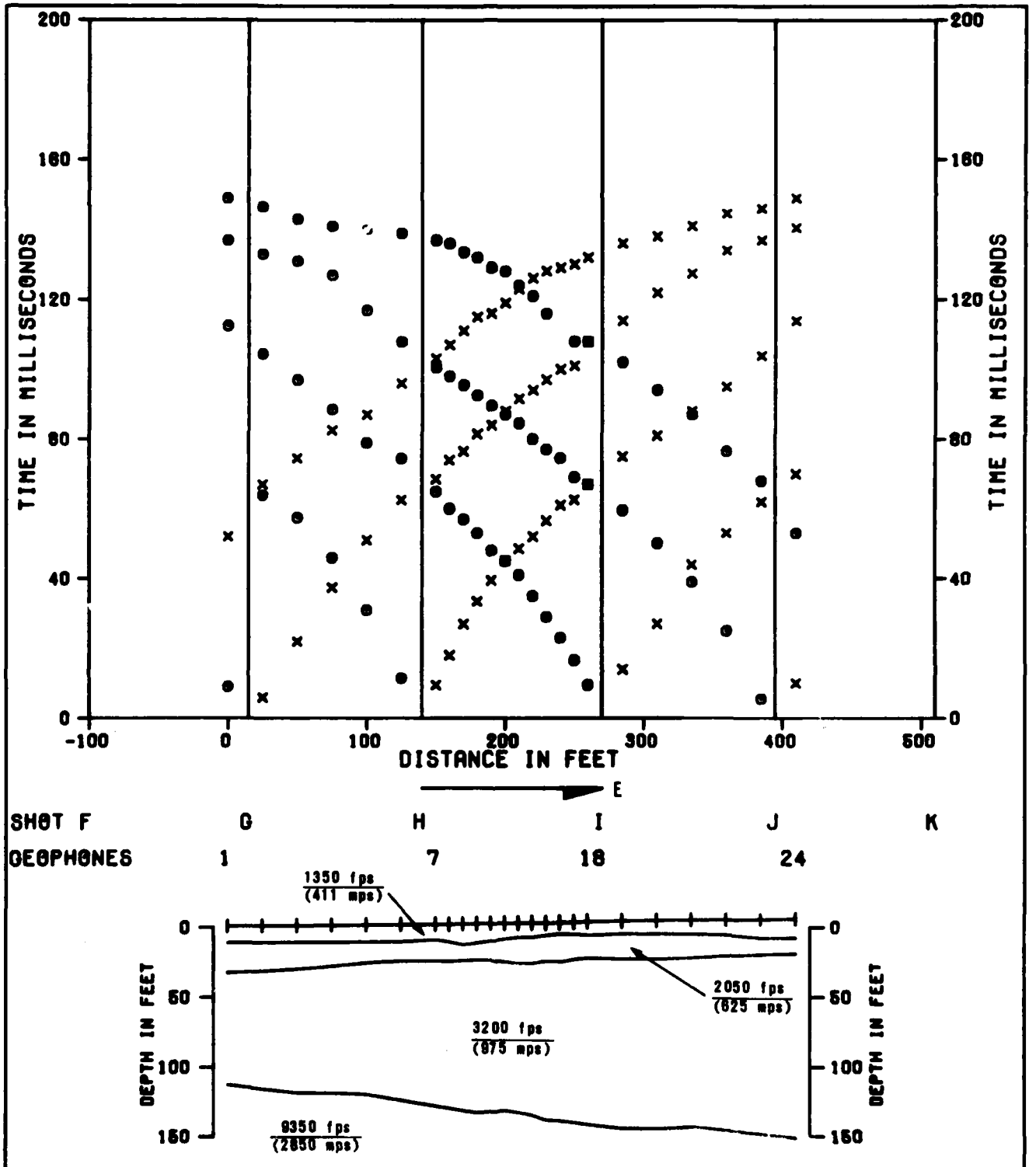
Each figure shows seismic wave travel times plotted versus surface distance between the energy source (shot) and the detector (geophone) for a single seismic line. Distances are measured along the line from geophone number 1 which is designated as zero distance. Distances to the right (on the paper) of geophone 1 are positive. The direction arrow gives the approximate direction of the geophone array from geophone 1 to geophone 24.

Travel Time Versus Distance Graph (Upper Half of Figure)

This is a travel time versus distance graph. The abscissa represents distance; the ordinate, time. The six vertical lines represent the locations of shots (designated as F, G, H, I, J, and K). The symbol, X, denotes travel times at geophones that were located to the right of a shot. The symbol, ⊖, denotes travel times that were located to the left of shots.

Velocity Cross Section (Lower Half of Figure)

This is an interpreted velocity cross section beneath the seismic line. The top line represents the ground-surface profile. The short vertical lines crossing the top line mark the geophone positions. The depth scale is plotted relative to a point on the line which was arbitrarily chosen as "zero elevation" at the time the line was surveyed. The additional lines across the cross section represent the interpreted boundaries between layers of material with different compressional wave velocities. These boundaries are commonly called "refractors". The velocity interpreted to be representative of each layer is shown.

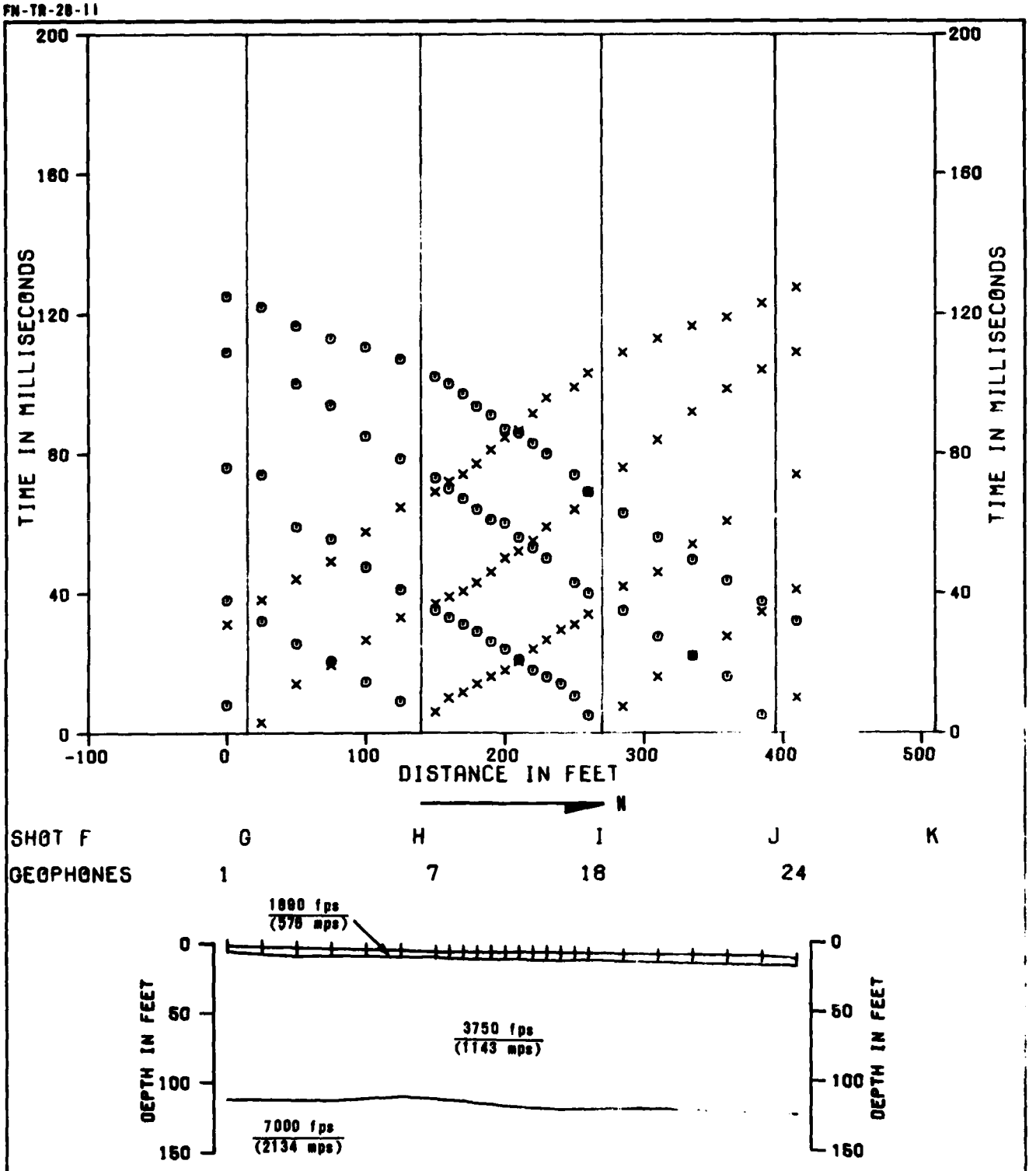


SEISMIC REFRACTION LINE BU-S-1
TIME DISTANCE DATA AND VELOCITY PROFILE
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE
3-1

FN-TR-28-11



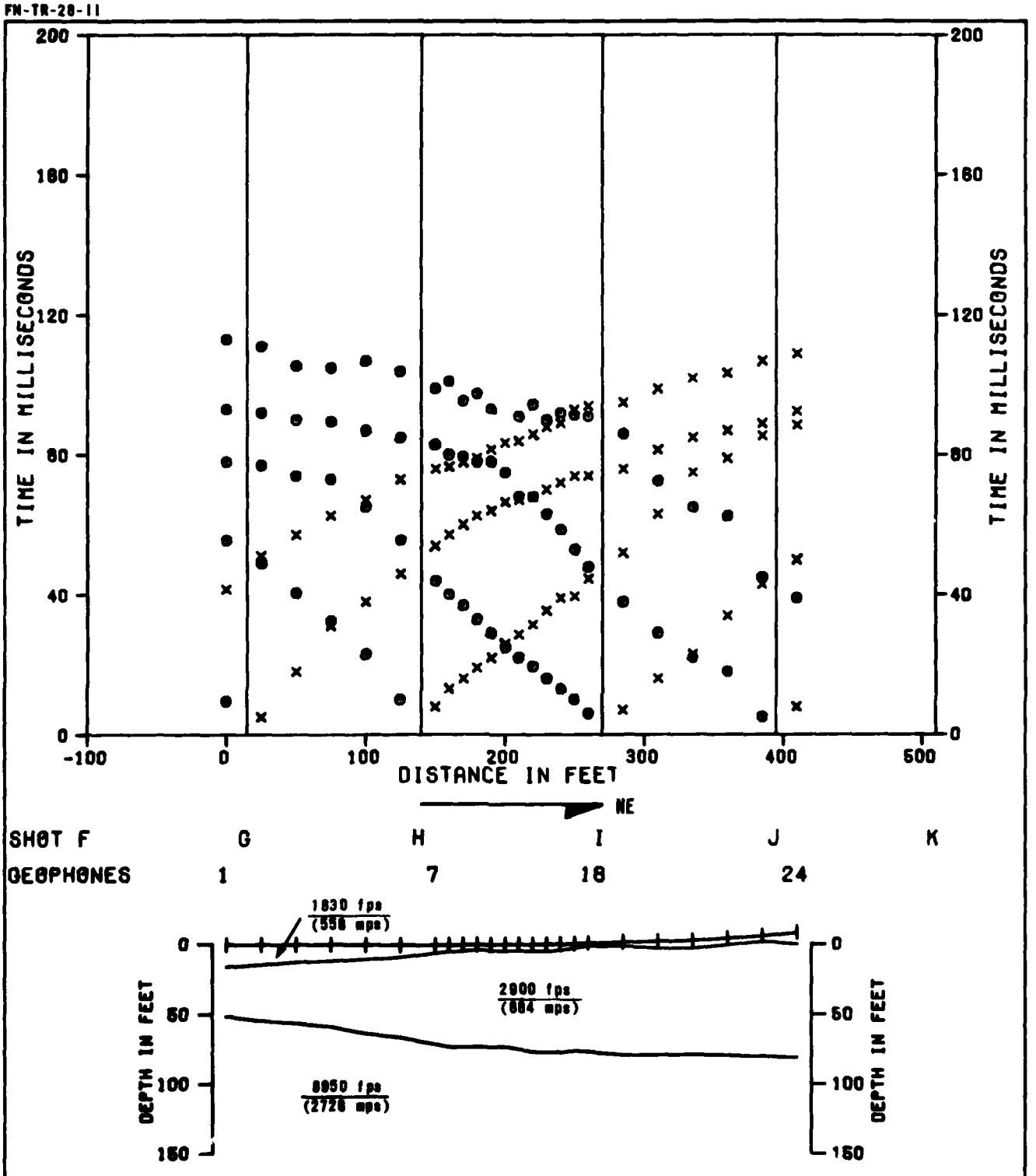
SEISMIC REFRACTION LINE BU-S-3
TIME DISTANCE DATA AND VELOCITY PROFILE
VERIFICATION SITE, BUTLER COP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE 3-3

FUGRO NATIONAL, INC.

10 AUG 78

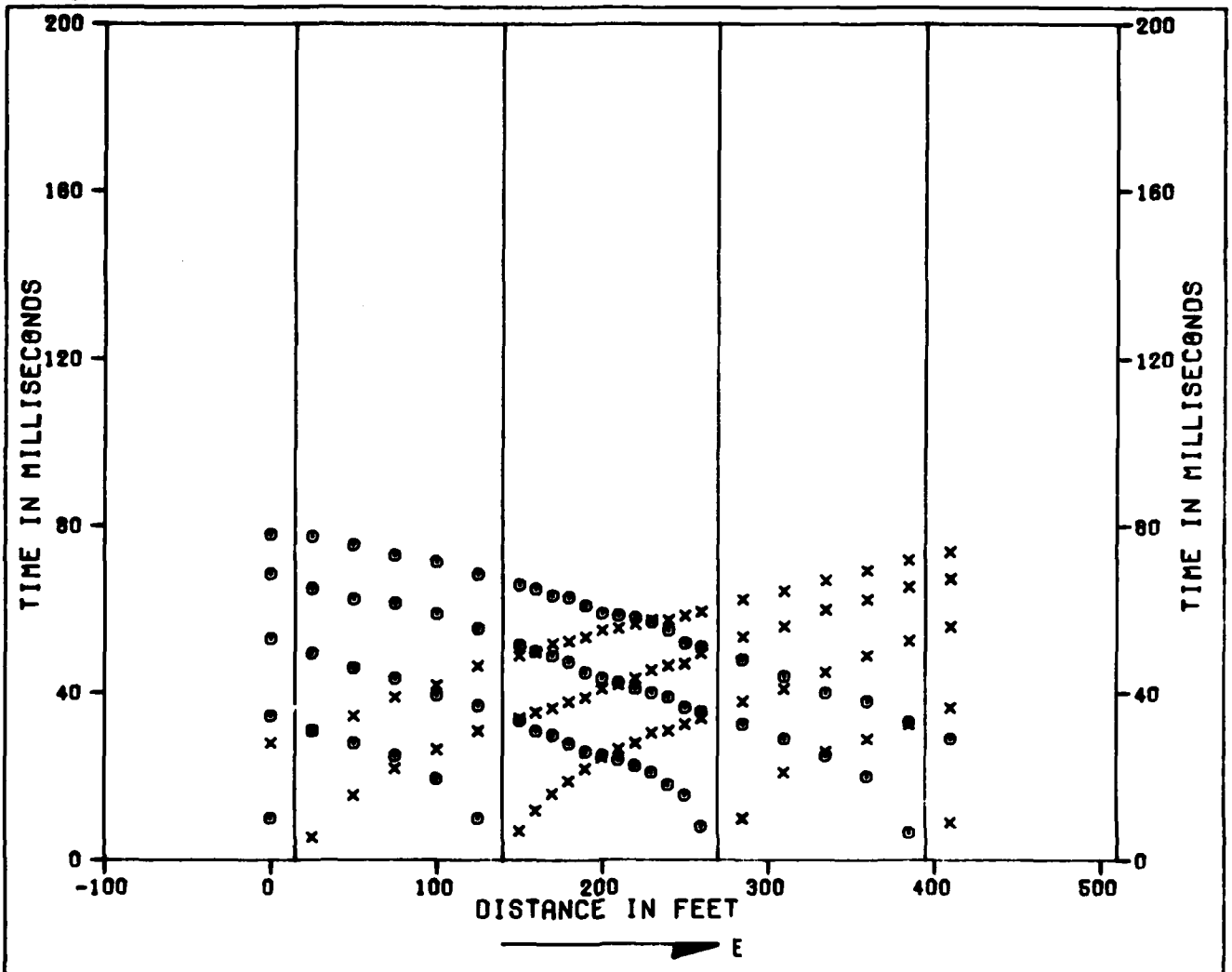


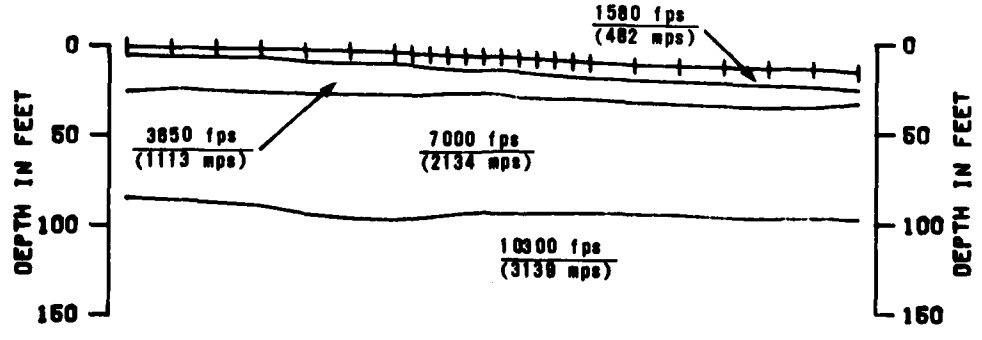
SEISMIC REFRACTION LINE BU-S-4
TIME DISTANCE DATA AND VELOCITY PROFILE
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE
3-4

TERRA NATIONAL, INC.





0 METERS 50
DISTANCE AND DEPTH

× TIMES TO RIGHT OF SHOTS
⊙ TIMES TO LEFT OF SHOTS

SEISMIC REFRACTION LINE BU-S-5
TIME DISTANCE DATA AND VELOCITY PROFILE
VERIFICATION SITE, BUTLER COP, ARIZONA

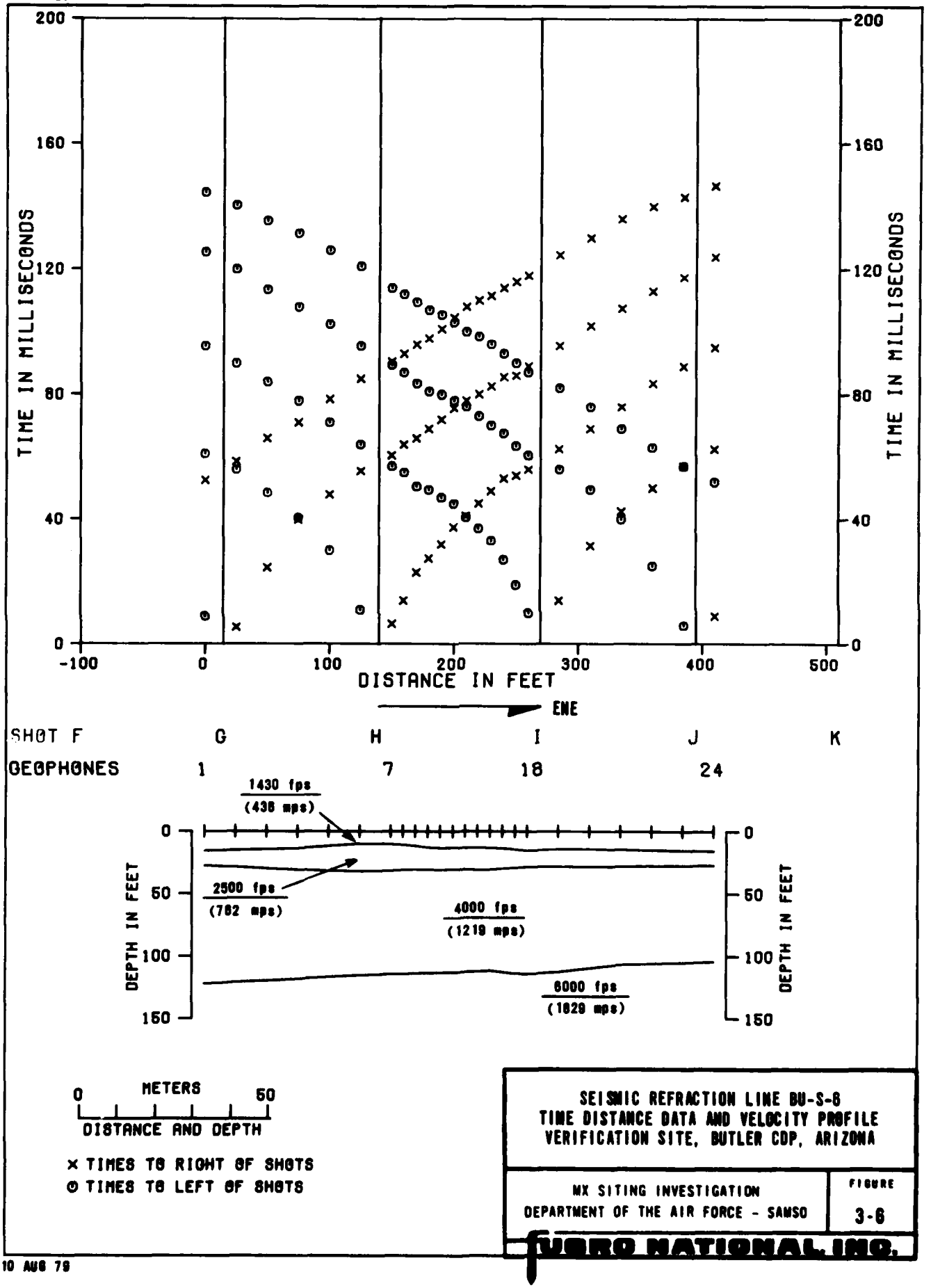
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE 3-5

WOODWARD-CLYDE CONSULTANTS

10 AUG 79

FN-TR-28-11



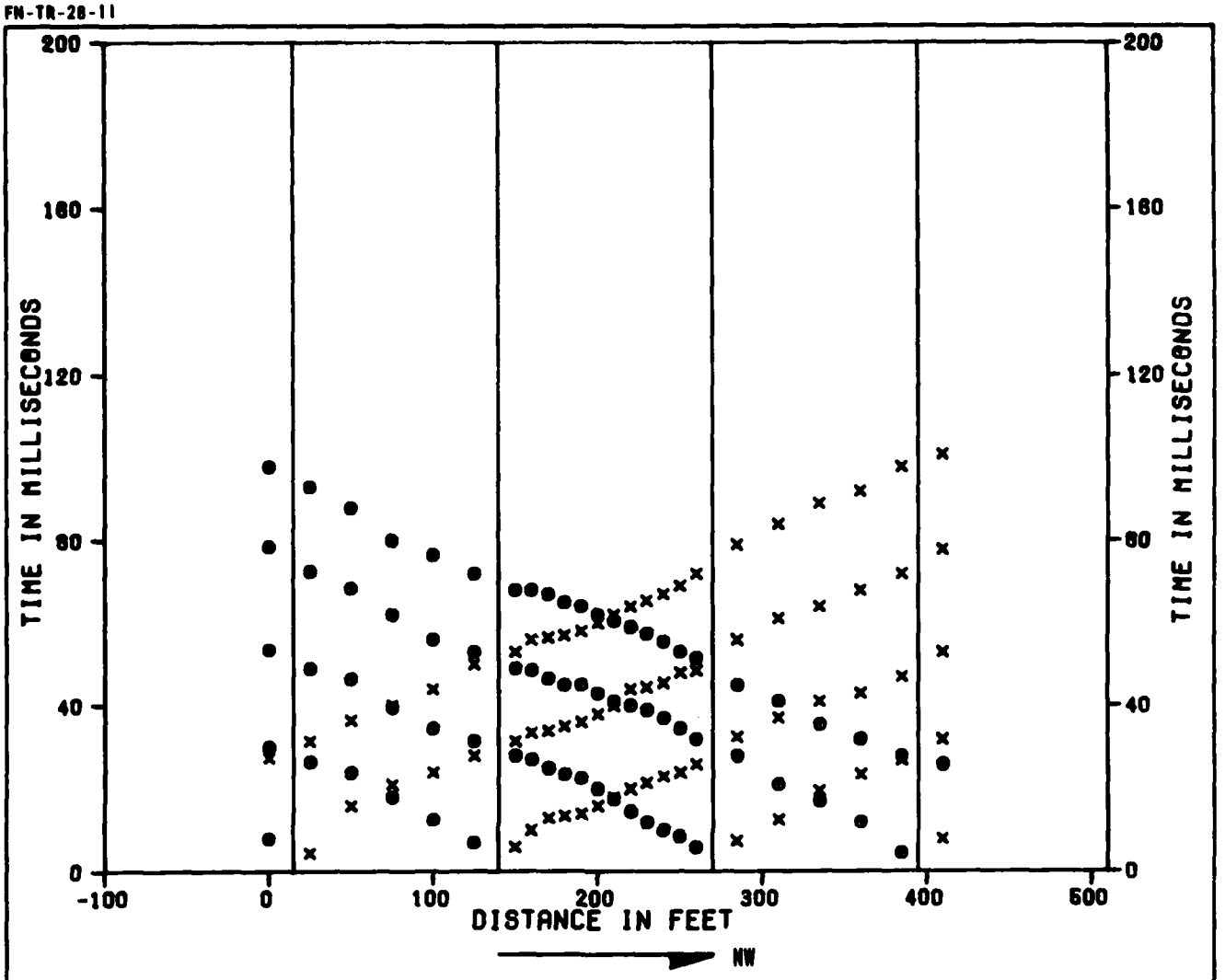
SEISMIC REFRACTION LINE BU-S-6
TIME DISTANCE DATA AND VELOCITY PROFILE
VERIFICATION SITE, BUTLER COP, ARIZONA

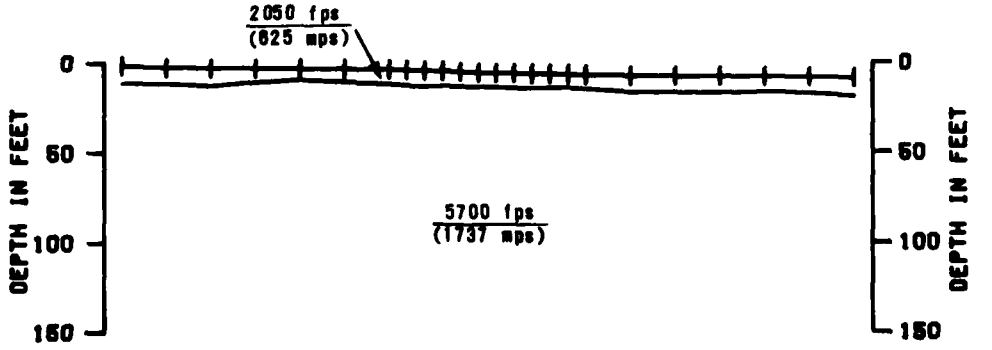
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE
3-6

WOODWARD-CLYDE CONSULTANTS

10 AUG 79





0 METERS 50

DISTANCE AND DEPTH

× TIMES TO RIGHT OF SHOTS

⊙ TIMES TO LEFT OF SHOTS

SEISMIC REFRACTION LINE BU-S-7
TIME DISTANCE DATA AND VELOCITY PROFILE
VERIFICATION SITE, BUTLER COP, ARIZONA

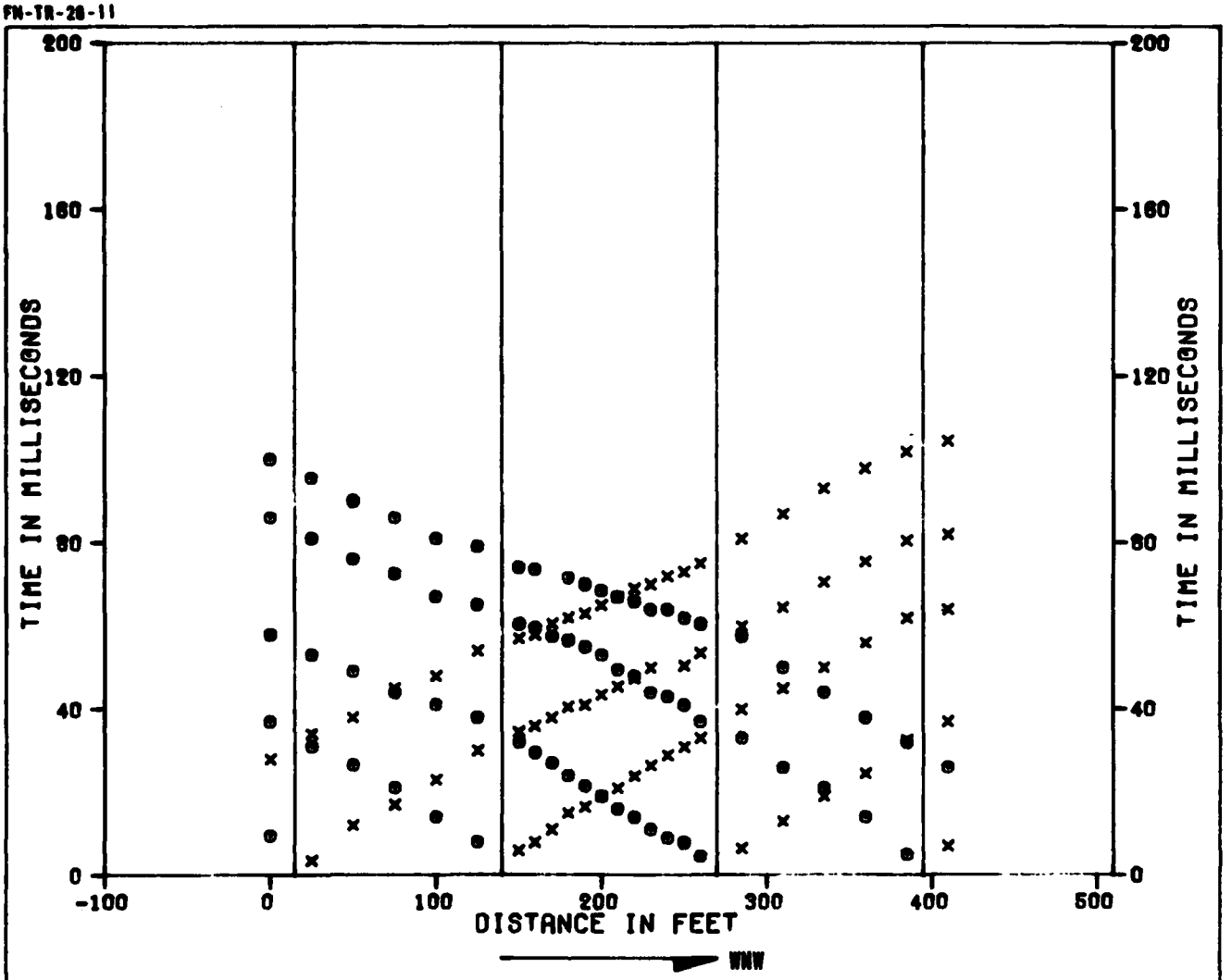
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

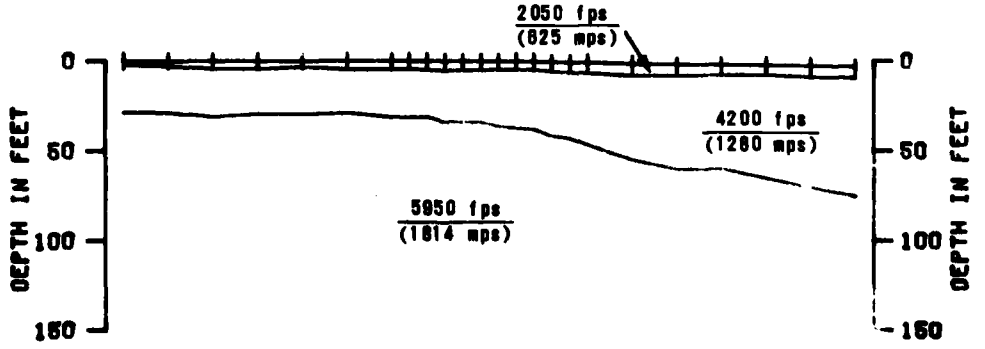
FIGURE 3-7

WOODWARD-CLYDE CONSULTANTS

10 AUG 79

FN-TR-28-11





0 METERS 50
DISTANCE AND DEPTH

× TIMES TO RIGHT OF SHOTS
⊙ TIMES TO LEFT OF SHOTS

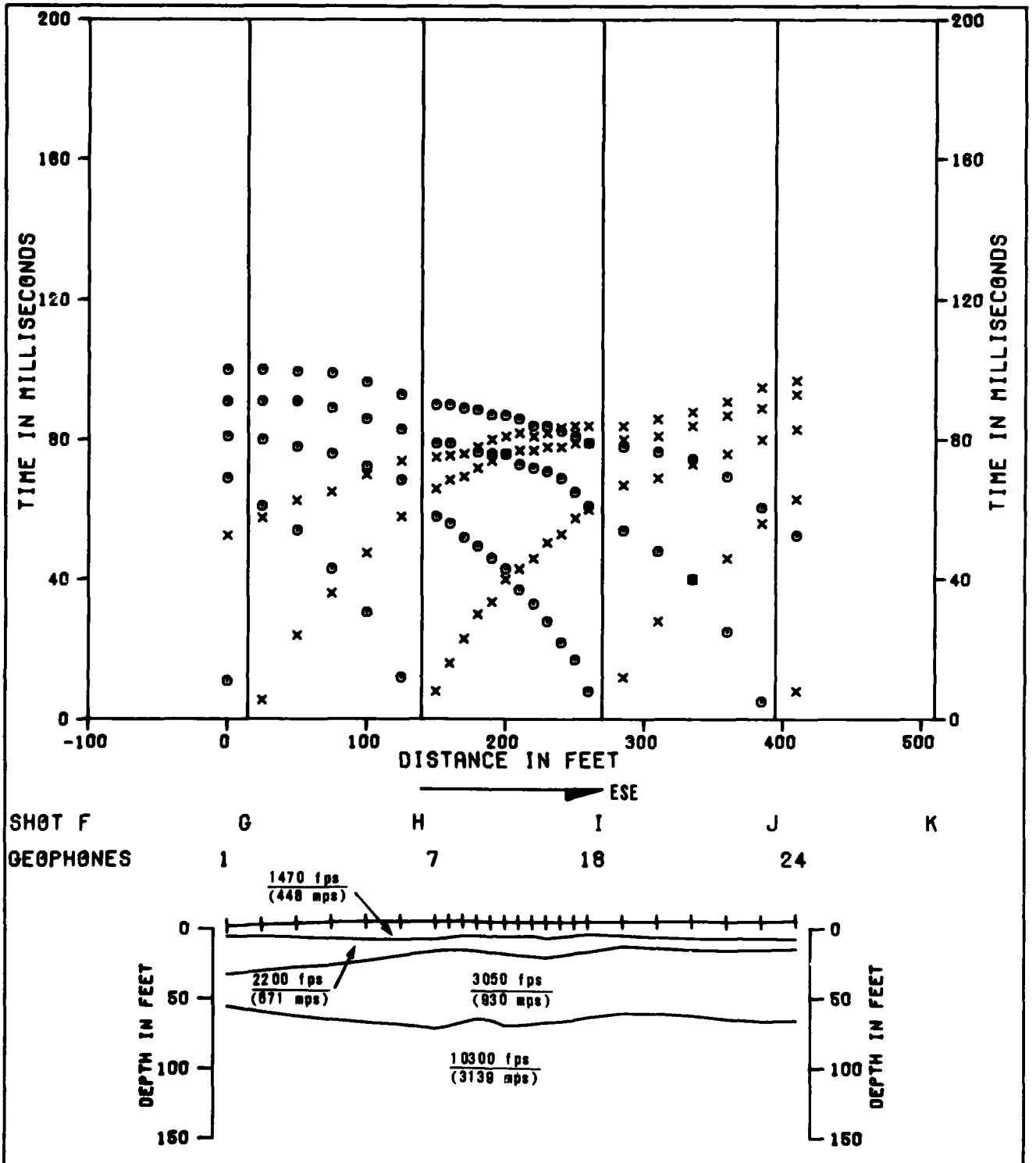
SEISMIC REFRACTION LINE BU-S-8
TIME DISTANCE DATA AND VELOCITY PROFILE
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE 3-8

WOODWARD-NATIONAL, INC.

10 AUG 79



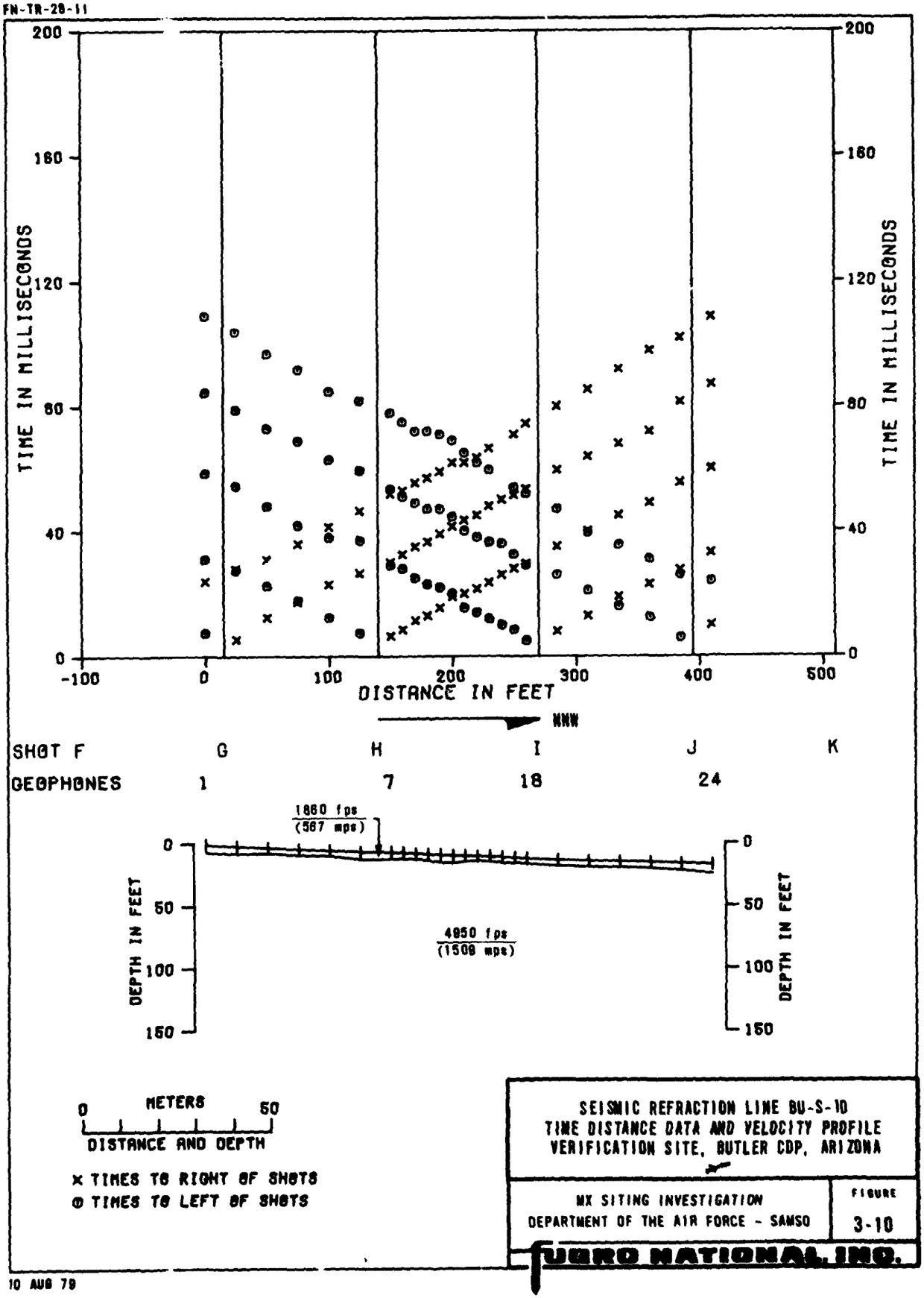
SEISMIC REFRACTION LINE BU-S-9
TIME DISTANCE DATA AND VELOCITY PROFILE
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE 3-9

FUGRO NATIONAL, INC.

FN-TR-28-11



SEISMIC REFRACTION LINE BU-S-10
TIME DISTANCE DATA AND VELOCITY PROFILE
VERIFICATION SITE, BUTLER CDP, ARIZONA

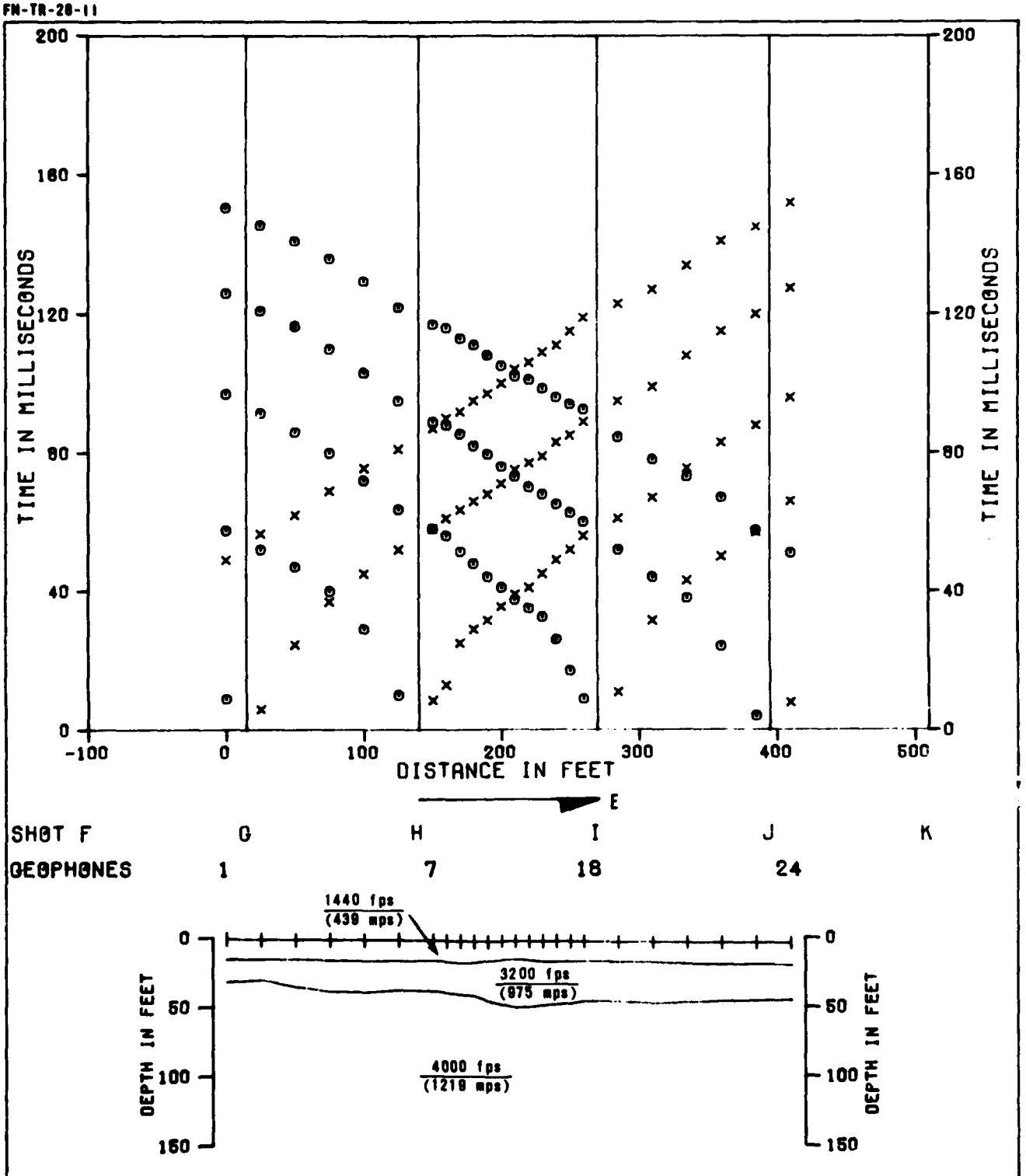
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE
3-10

UBRO NATIONAL, INC.

10 AUG 79

FN-TR-20-11



SEISMIC REFRACTION LINE BU-S-11
TIME DISTANCE DATA AND VELOCITY PROFILE
VERIFICATION SITE, BUTLER COP, ARIZONA

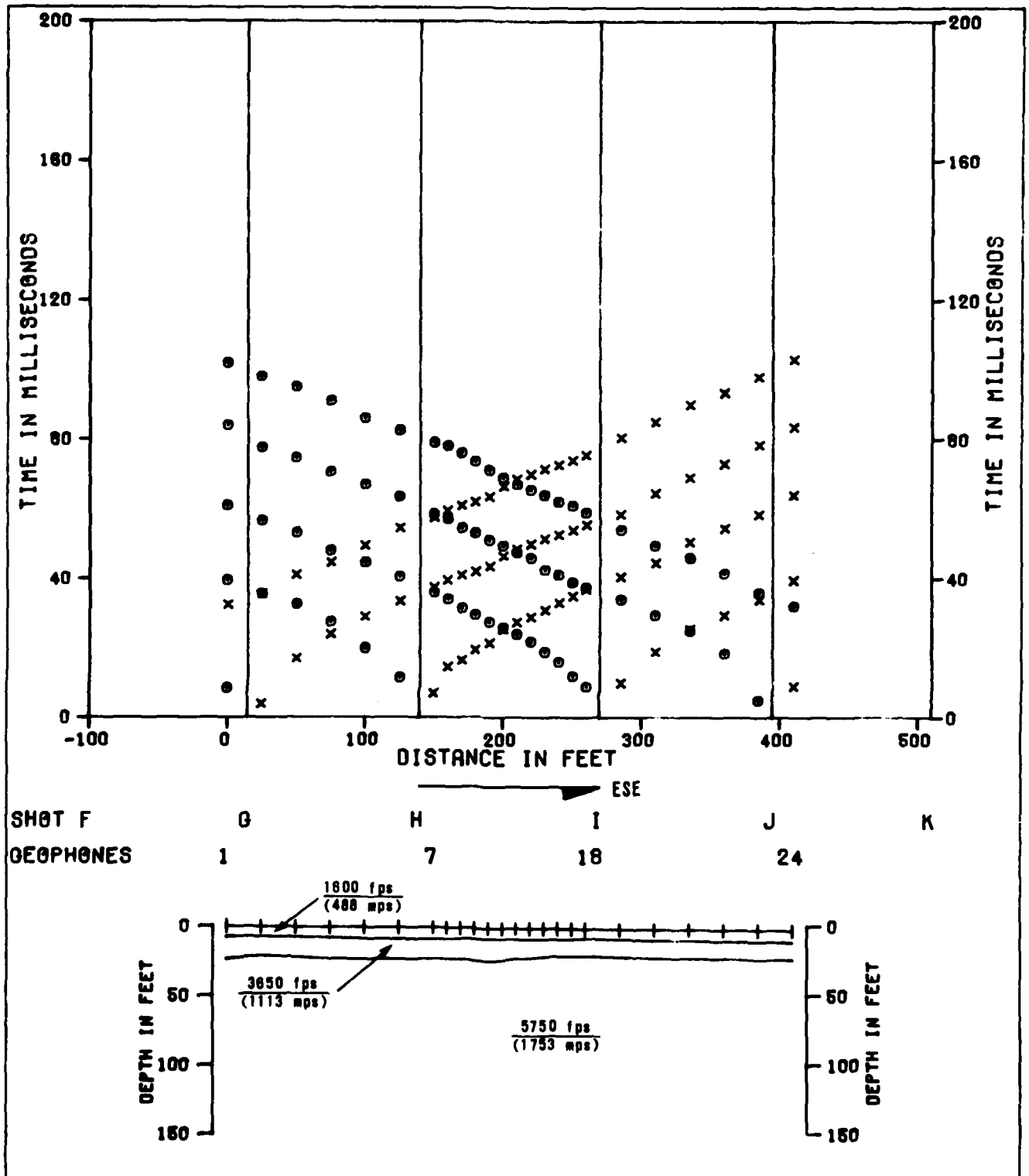
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE 3-11

URS RESEARCH CO.

10 AUG 79

FN-TR-28-11



SEISMIC REFRACTION LINE BU-S-12
TIME DISTANCE DATA AND VELOCITY PROFILE
VERIFICATION SITE, BUTLER COP, ARIZONA

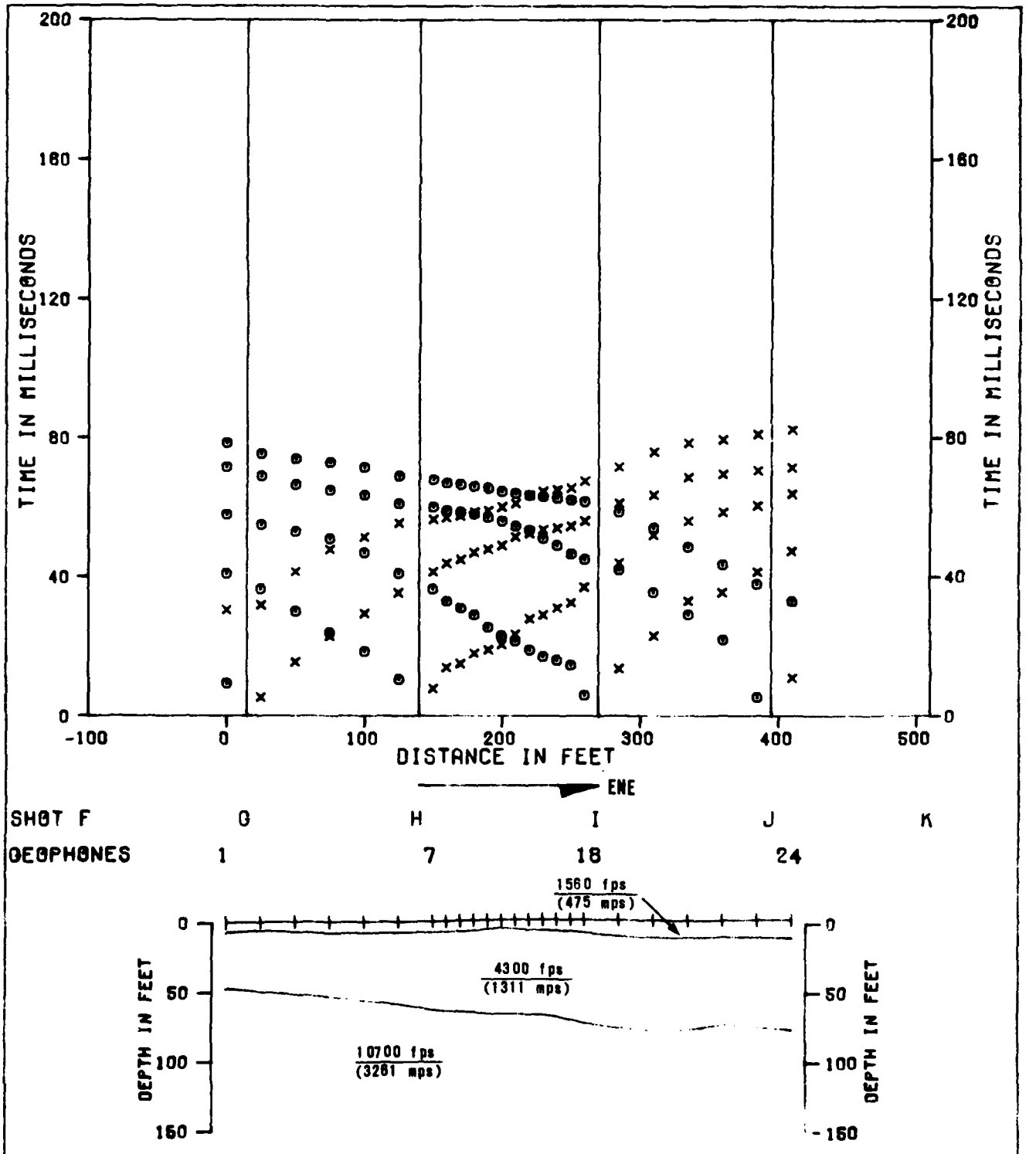
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE 3-12

WOODWARD-CLYDE CONSULTANTS

10 AUG 79

FN-TR-28-11



SEISMIC REFRACTION LINE BU-S-13
TIME DISTANCE DATA AND VELOCITY PROFILE
VERIFICATION SITE, BUTLER CDP, ARIZONA

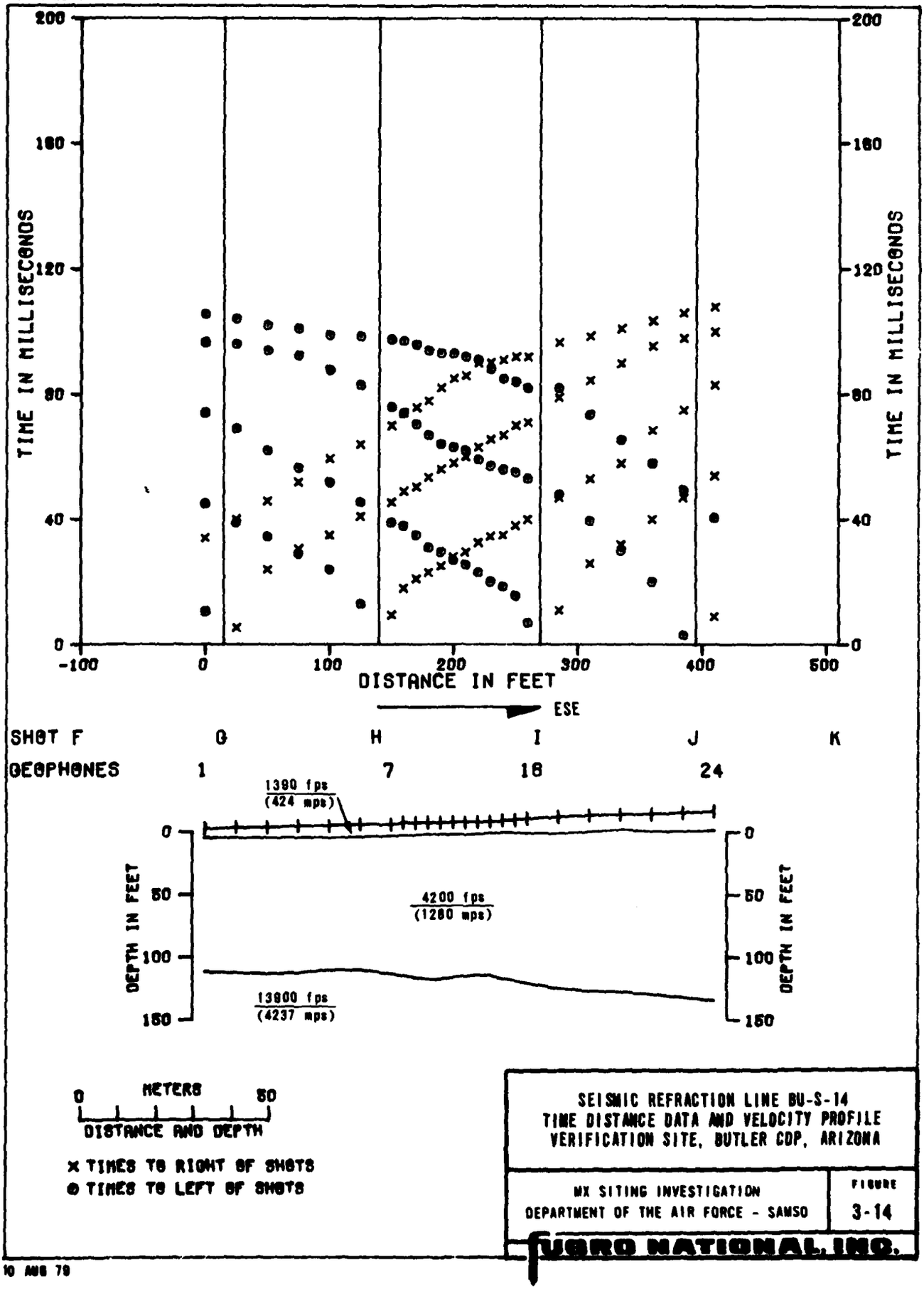
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE
3-13

WOODWARD-CLYDE CONSULTANTS

10 AUG 79

FN-TR-28-11



SEISMIC REFRACTION LINE BU-S-14
TIME DISTANCE DATA AND VELOCITY PROFILE
VERIFICATION SITE, BUTLER COP, ARIZONA

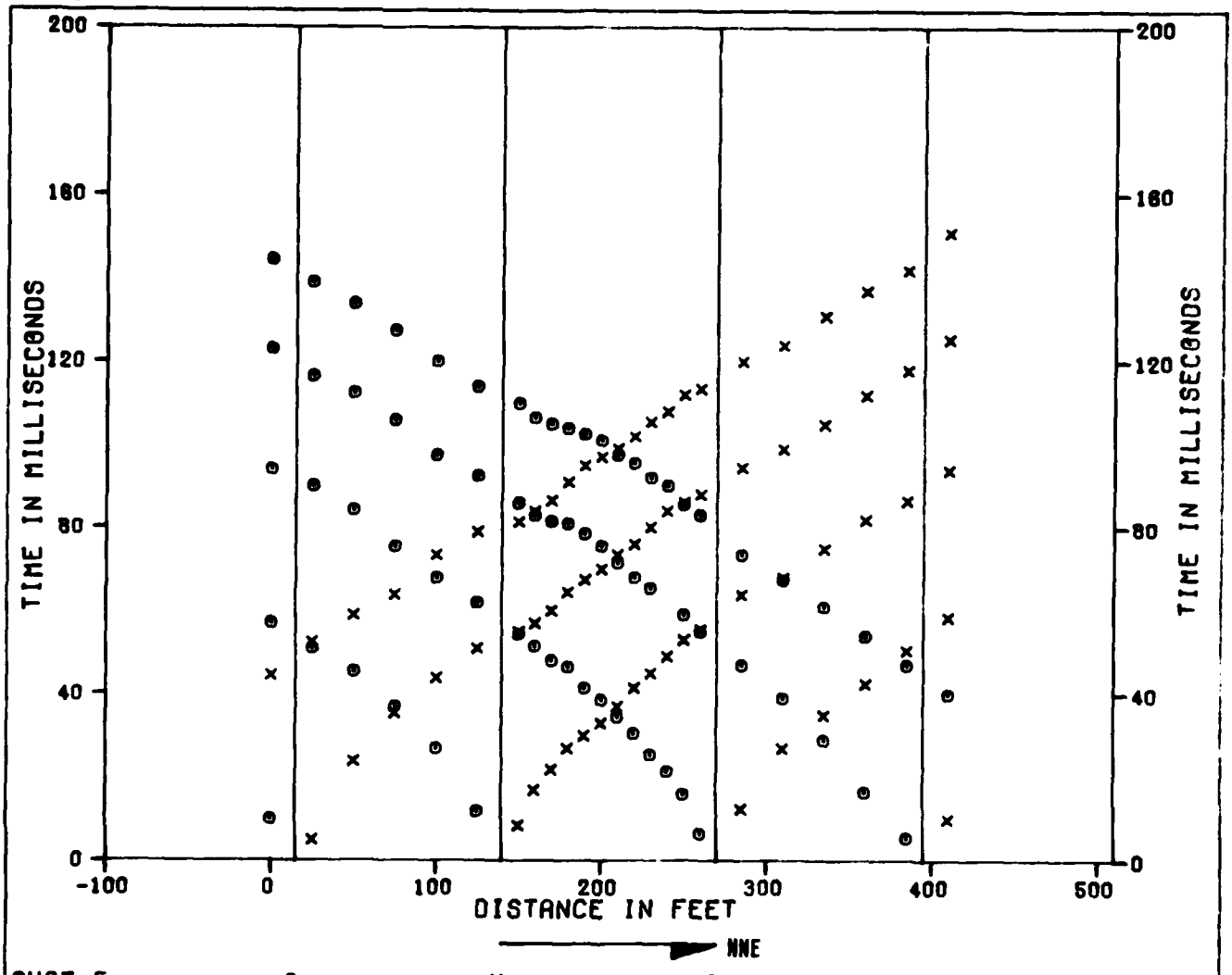
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

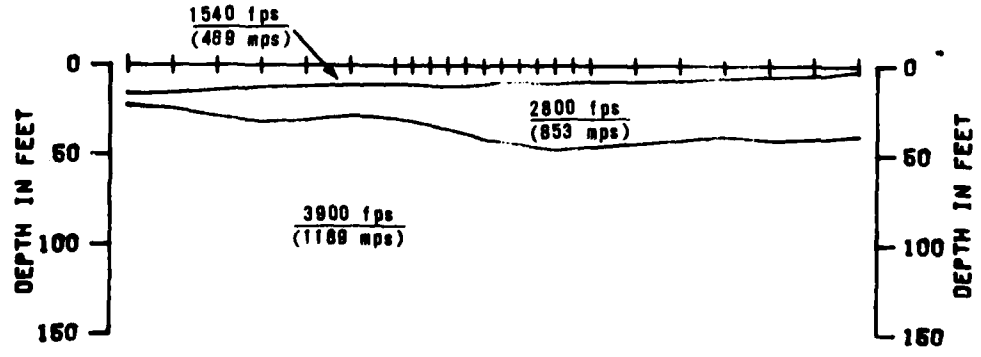
FIGURE
3-14

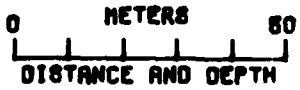
FUGRO NATIONAL, INC.

10 AUG 79

FN-TR-28-11







× TIMES TO RIGHT OF SHOTS
● TIMES TO LEFT OF SHOTS

SEISMIC REFRACTION LINE BU-S-15
TIME DISTANCE DATA AND VELOCITY PROFILE
VERIFICATION SITE, BUTLER COP, ARIZONA

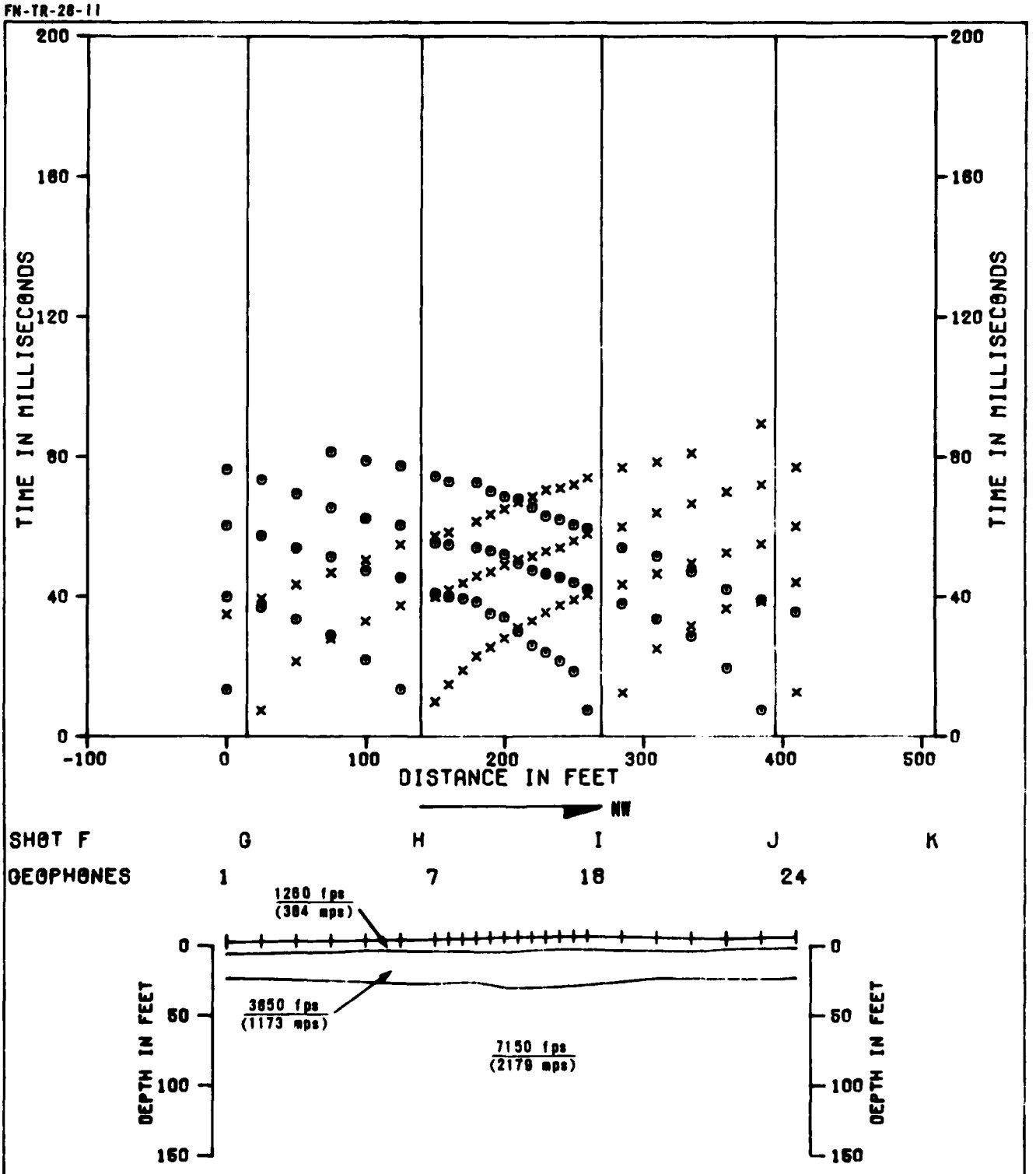
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE
3-15

WOODWARD-CLYDE CONSULTANTS

10 AUG 79

FN-TR-28-11



SEISMIC REFRACTION LINE BU-S-16
TIME DISTANCE DATA AND VELOCITY PROFILE
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE
3-16

URS RESEARCH COMPANY

10 AUG 79

SECTION 4.0

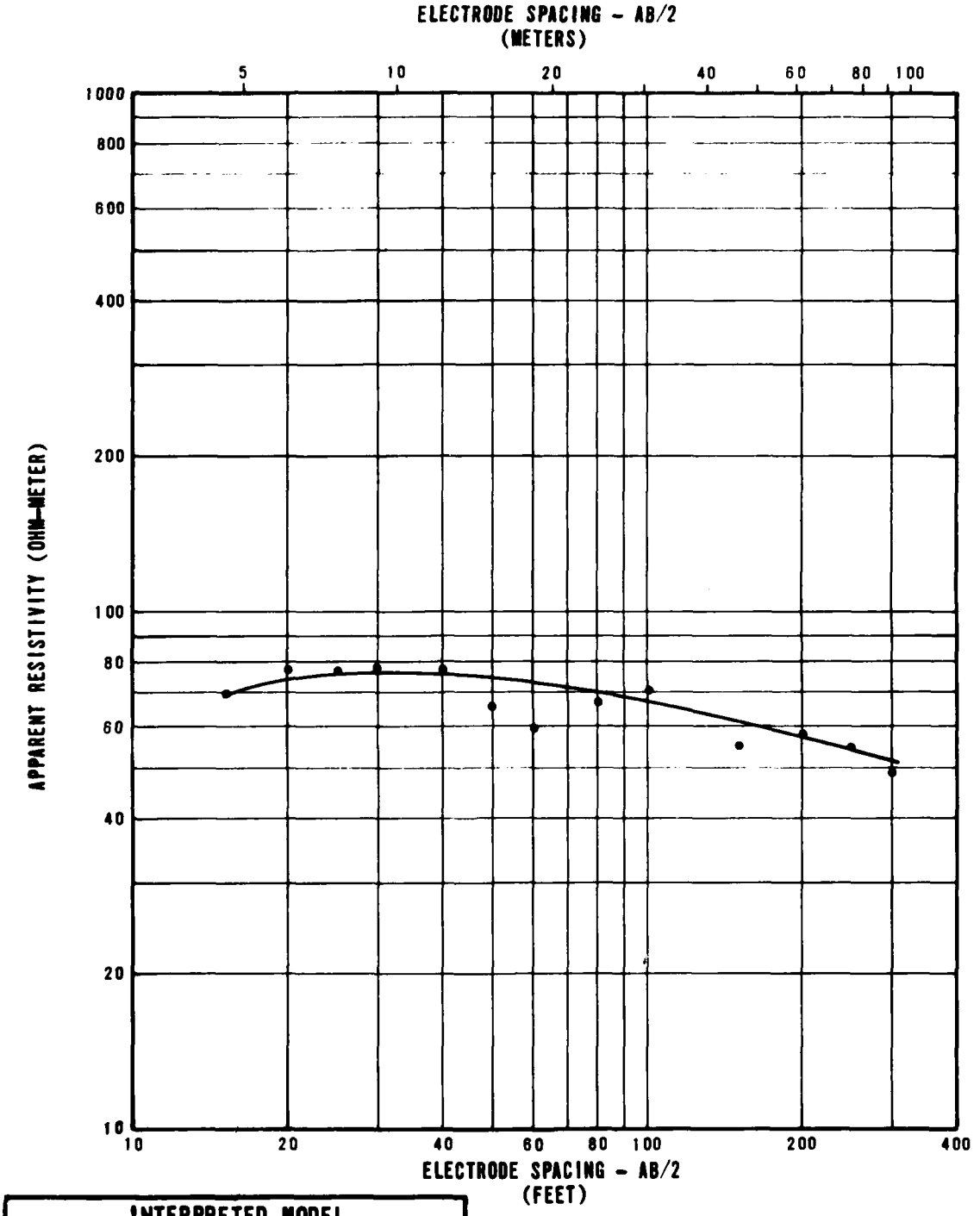
ELECTRICAL RESISTIVITY DATA

EXPLANATIONS OF ELECTRICAL RESISTIVITY DATA

Each figure in this section presents the data obtained from a resistivity sounding and a tabulated model of resistivity layers that would produce a curve similar to the observed curve.

The upper portion of the figures is a graph in which measured apparent resistivity values in ohm-meters are plotted versus one-half the distance between the current electrodes.

The interpreted model tabulated at the bottom of the page shows a combination of true resistivity layers and thicknesses obtained by matching theoretical curves to the field curve.



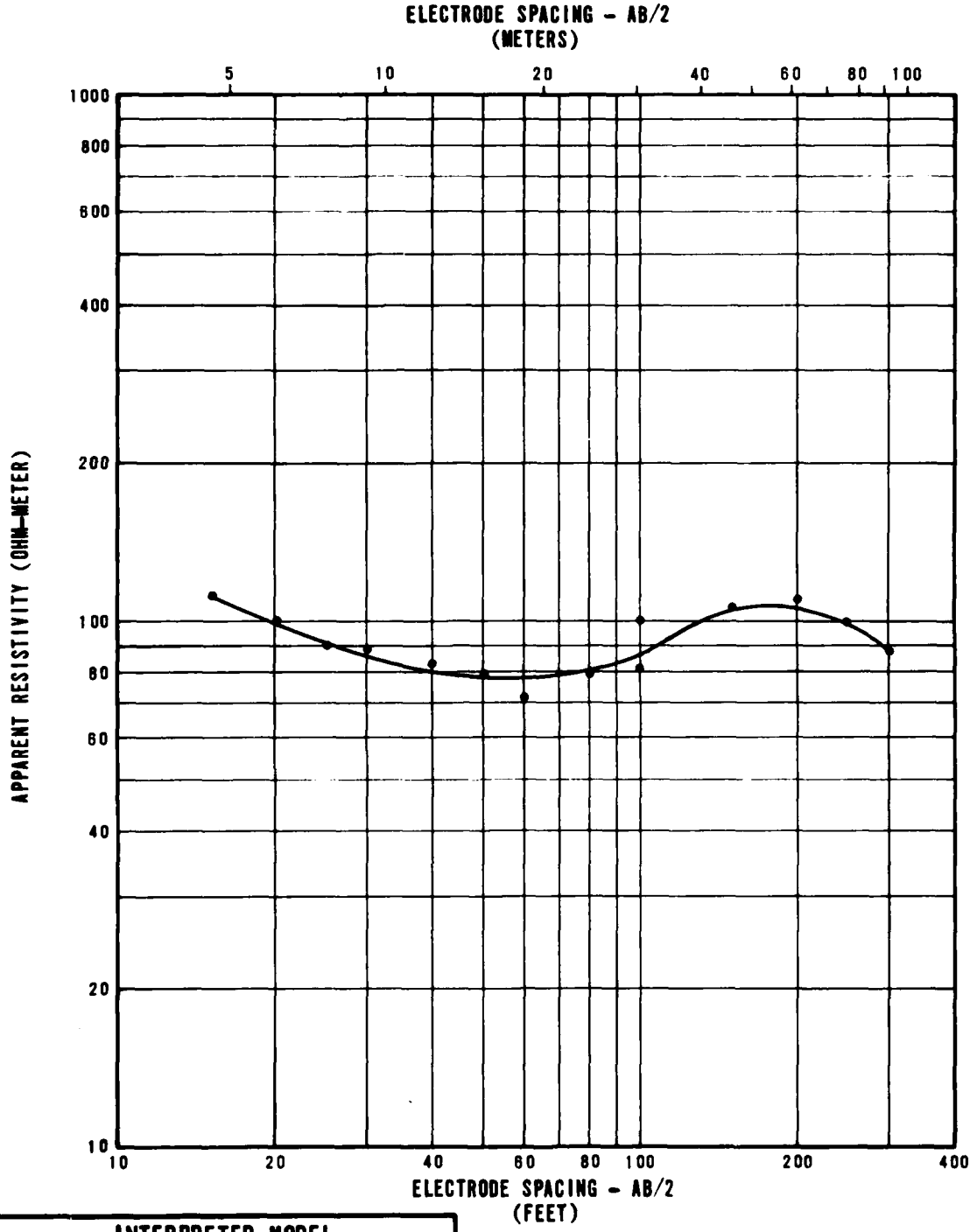
INTERPRETED MODEL		
LAYER DEPTH		RESISTIVITY VALUES
FEET	METERS	OHM-METER
0	0	70
15	5	85
49	15	45

RESISTIVITY SOUNDING BU-R-1
SOUNDING CURVE AND INTERPRETATION
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

FIGURE
4-1

FUGRO NATIONAL, INC.

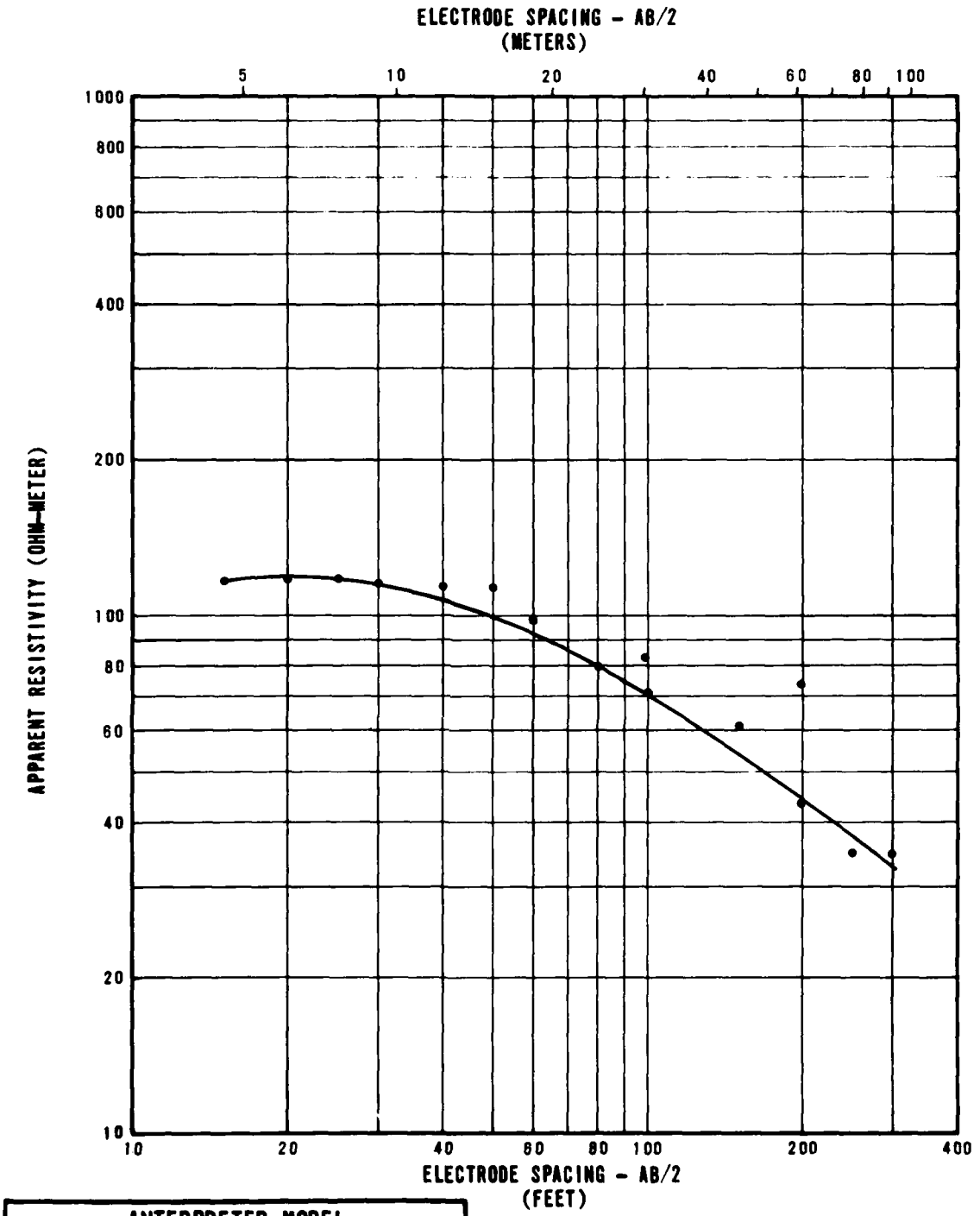


INTERPRETED MODEL		
LAYER DEPTH		RESISTIVITY VALUES
FEET	METERS	OHM-METER
0	0	140
5	2	80
70	21	300
92	28	150
182	49	35

RESISTIVITY SOUNDING BU-R-2
SOUNDING CURVE AND INTERPRETATION
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

FIGURE
4-2



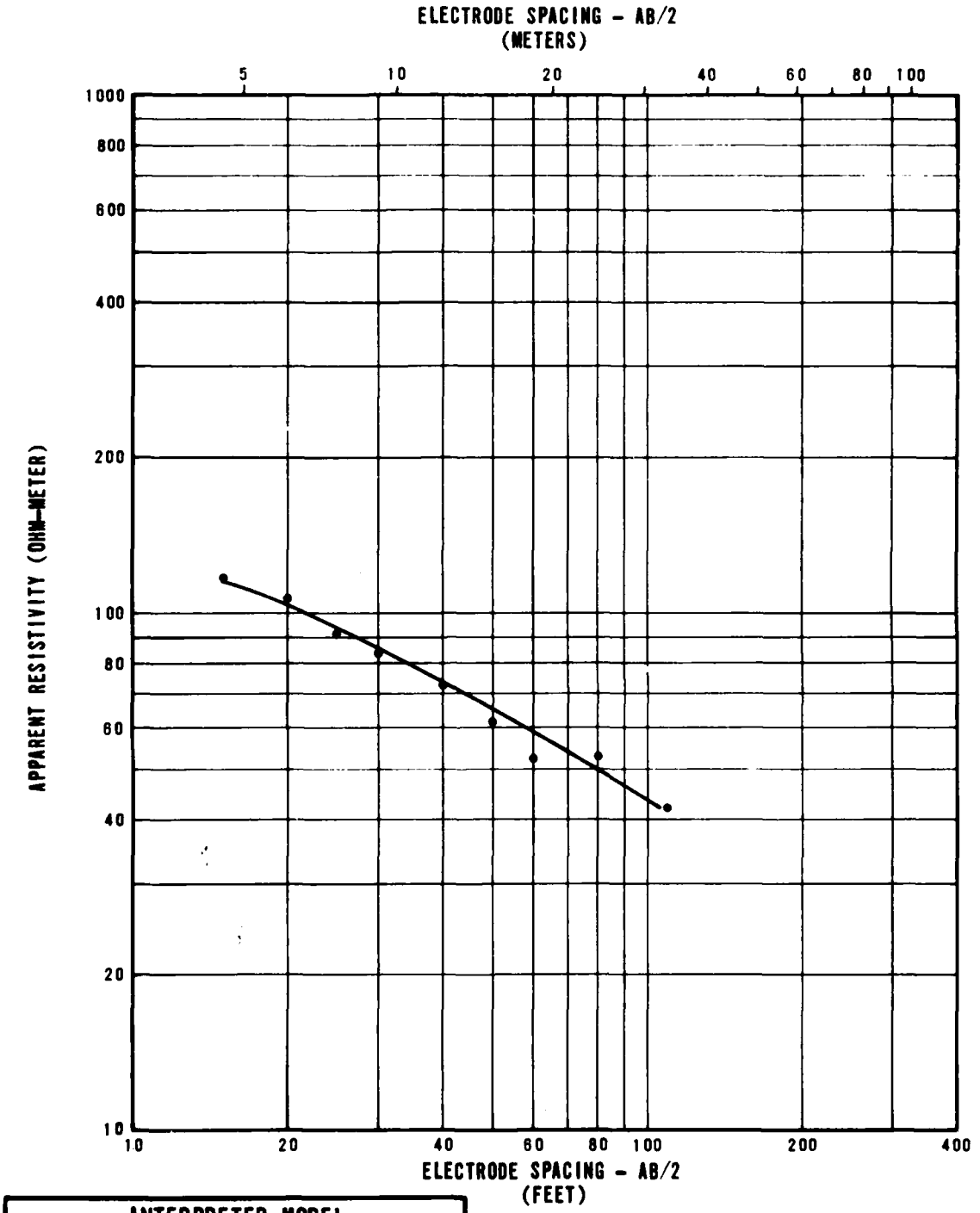
INTERPRETED MODEL		
LAYER DEPTH		RESISTIVITY VALUES
FEET	METERS	OHM-METER
0	0	120
36	12	30

RESISTIVITY SOUNDING BU-R-3
SOUNDING CURVE AND INTERPRETATION
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

FIGURE
4-3

FUGRO NATIONAL, INC.



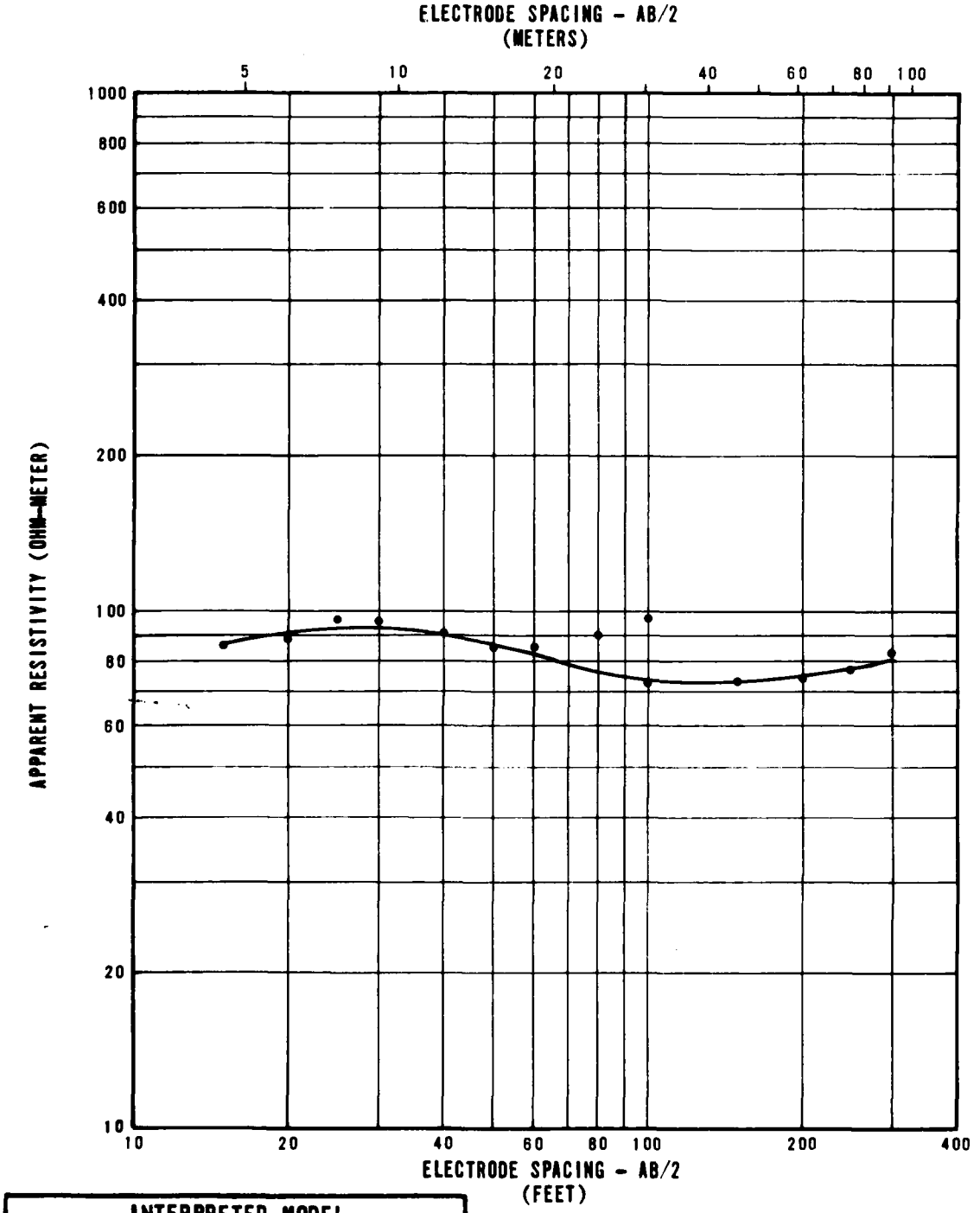
INTERPRETED MODEL		
LAYER DEPTH		RESISTIVITY VALUES
FEET	METERS	OHM-METER
0	0	130
15	5	45
79	24	20

RESISTIVITY SOUNDING BU-R-5
SOUNDING CURVE AND INTERPRETATION
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

FIGURE
4-4

FUGRO NATIONAL, INC.



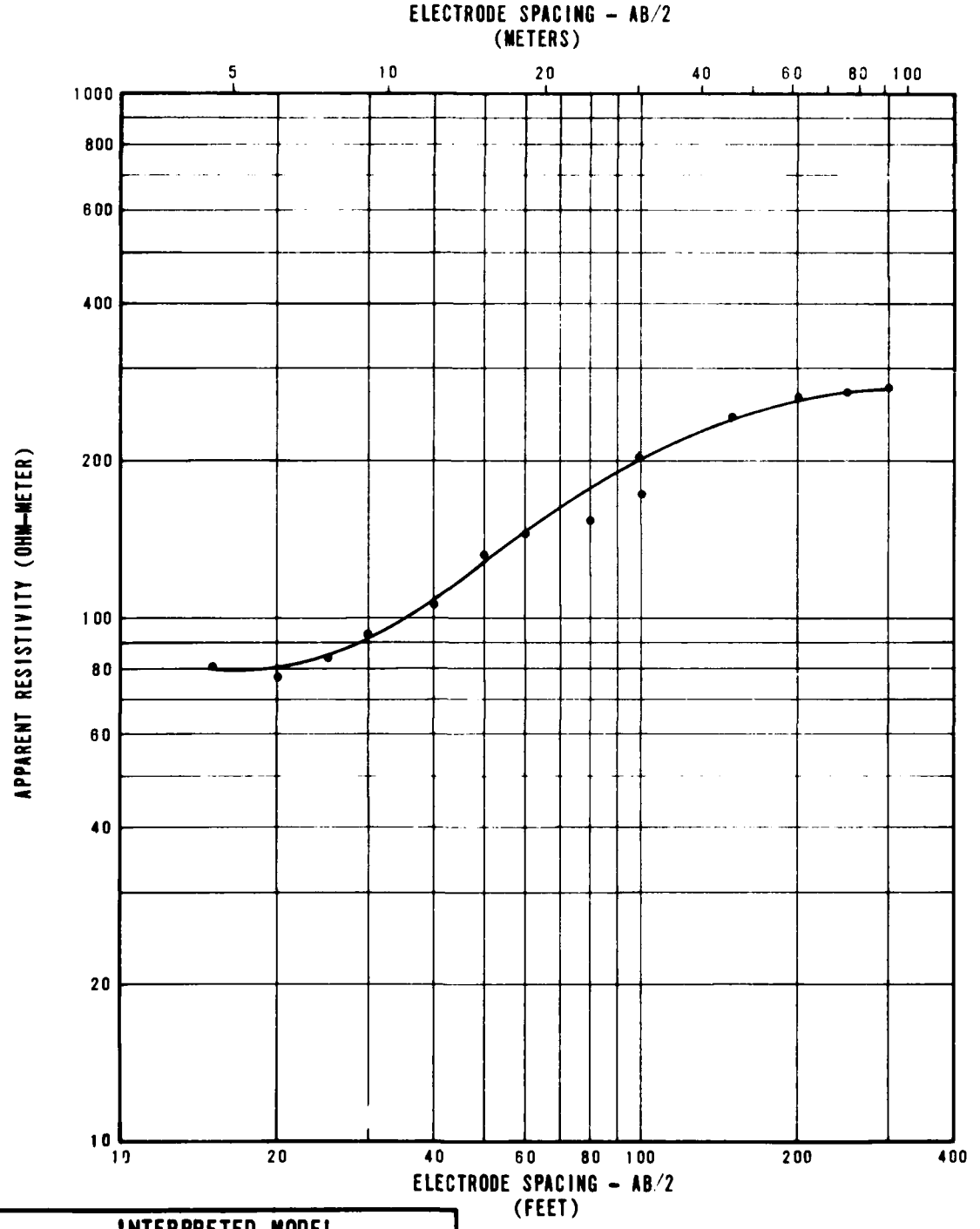
INTERPRETED MODEL		
LAYER DEPTH		RESISTIVITY VALUES
FEET	METERS	OHM-METER
0	0	100
22	7	65
115	35	100

RESISTIVITY SOUNDING BU-R-6
SOUNDING CURVE AND INTERPRETATION
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

FIGURE
4-5

FUGRO NATIONAL, INC.



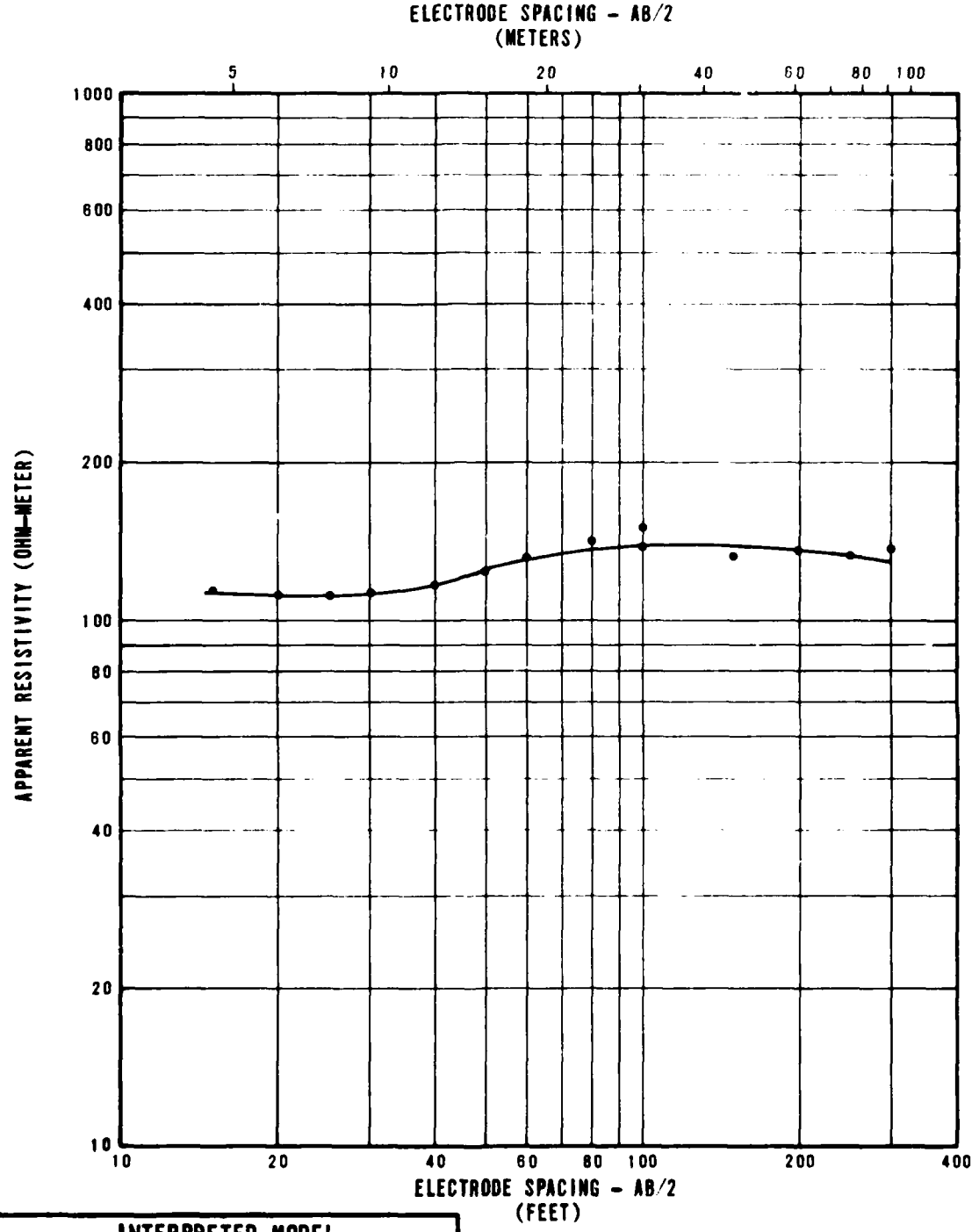
INTERPRETED MODEL		
LAYER DEPTH		RESISTIVITY VALUES
FEET	METERS	OHM-METER
0	0	75
24	7	410
158	48	190

RESISTIVITY SOUNDING BU-R-7
SOUNDING CURVE AND INTERPRETATION
VERIFICATION SITE, BUTLER COP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

FIGURE 4-6

FUGRO NATIONAL, INC.



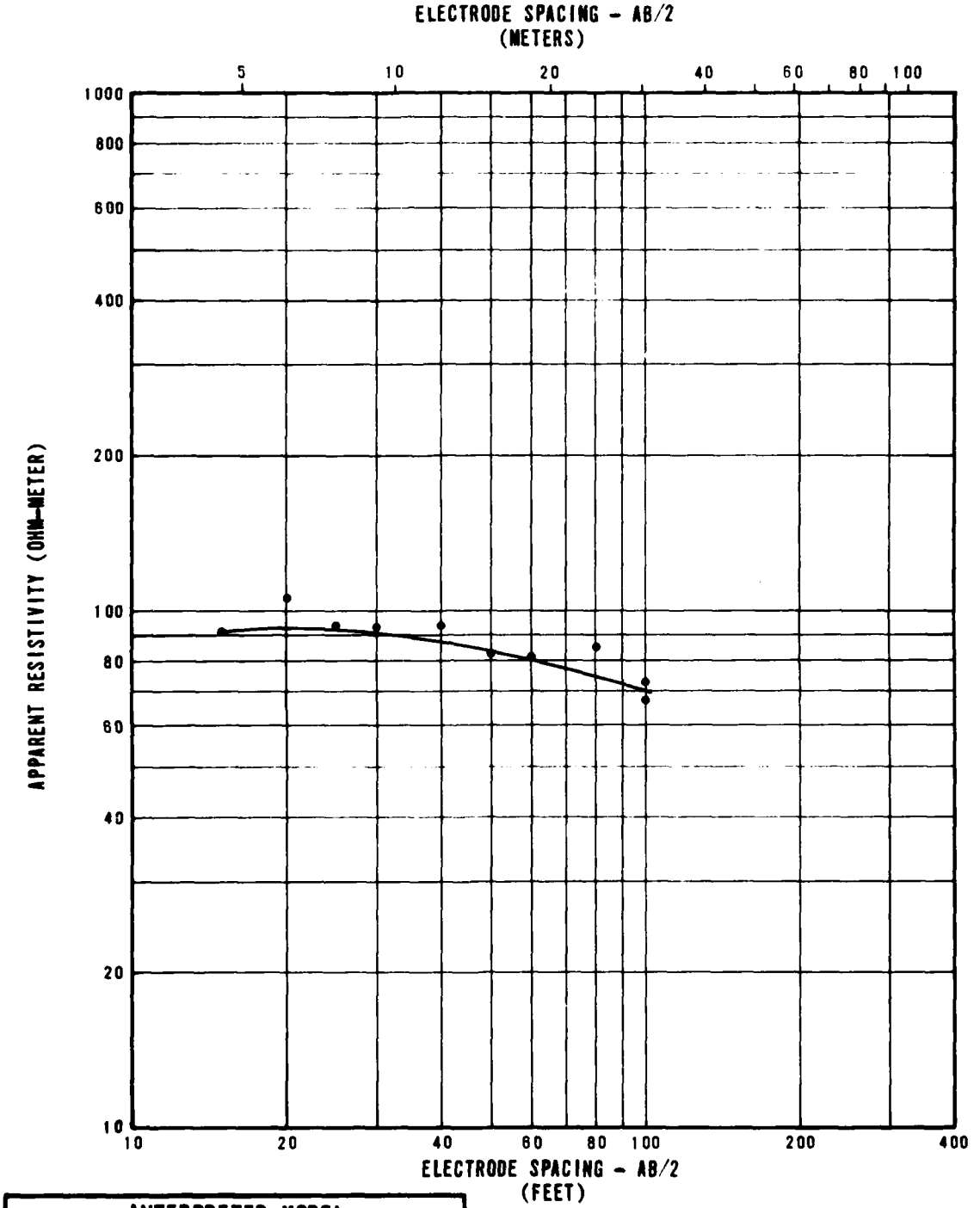
INTERPRETED MODEL		
LAYER DEPTH		RESISTIVITY VALUES
FEET	METERS	OHM-METER
0	0	110
37	11	210
79	24	110

RESISTIVITY SOUNDING BU-R-8
SOUNDING CURVE AND INTERPRETATION
VERIFICATION SITE, BUTLER COP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

FIGURE
4-7

FUGRO NATIONAL, INC.



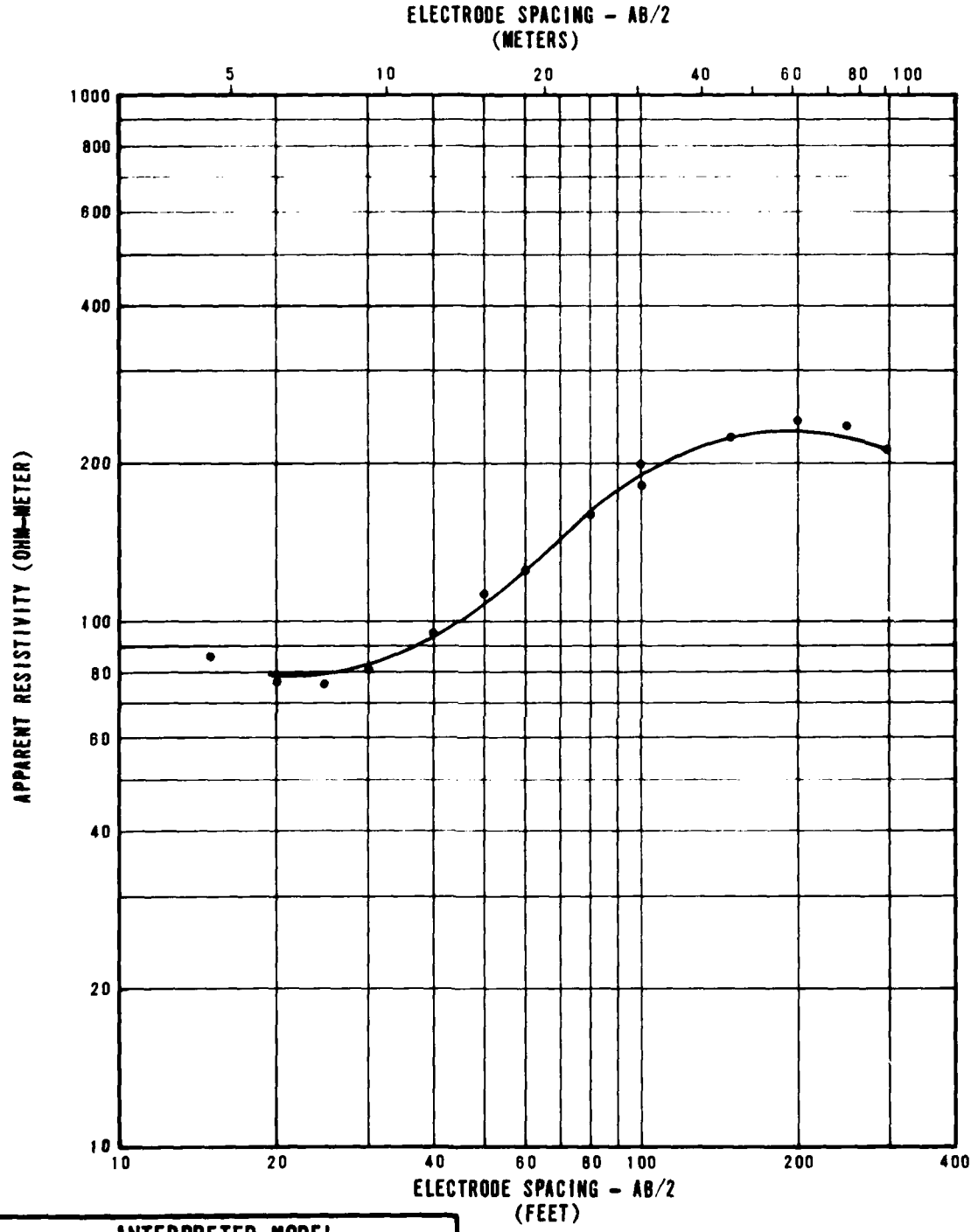
INTERPRETED MODEL		
LAYER DEPTH		RESISTIVITY VALUES
FEET	METERS	OHM-METER
0	0	90
40	12	50

RESISTIVITY SOUNDING BU-R-9
SOUNDING CURVE AND INTERPRETATION
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

FIGURE
4-8

FUGRO NATIONAL, INC.



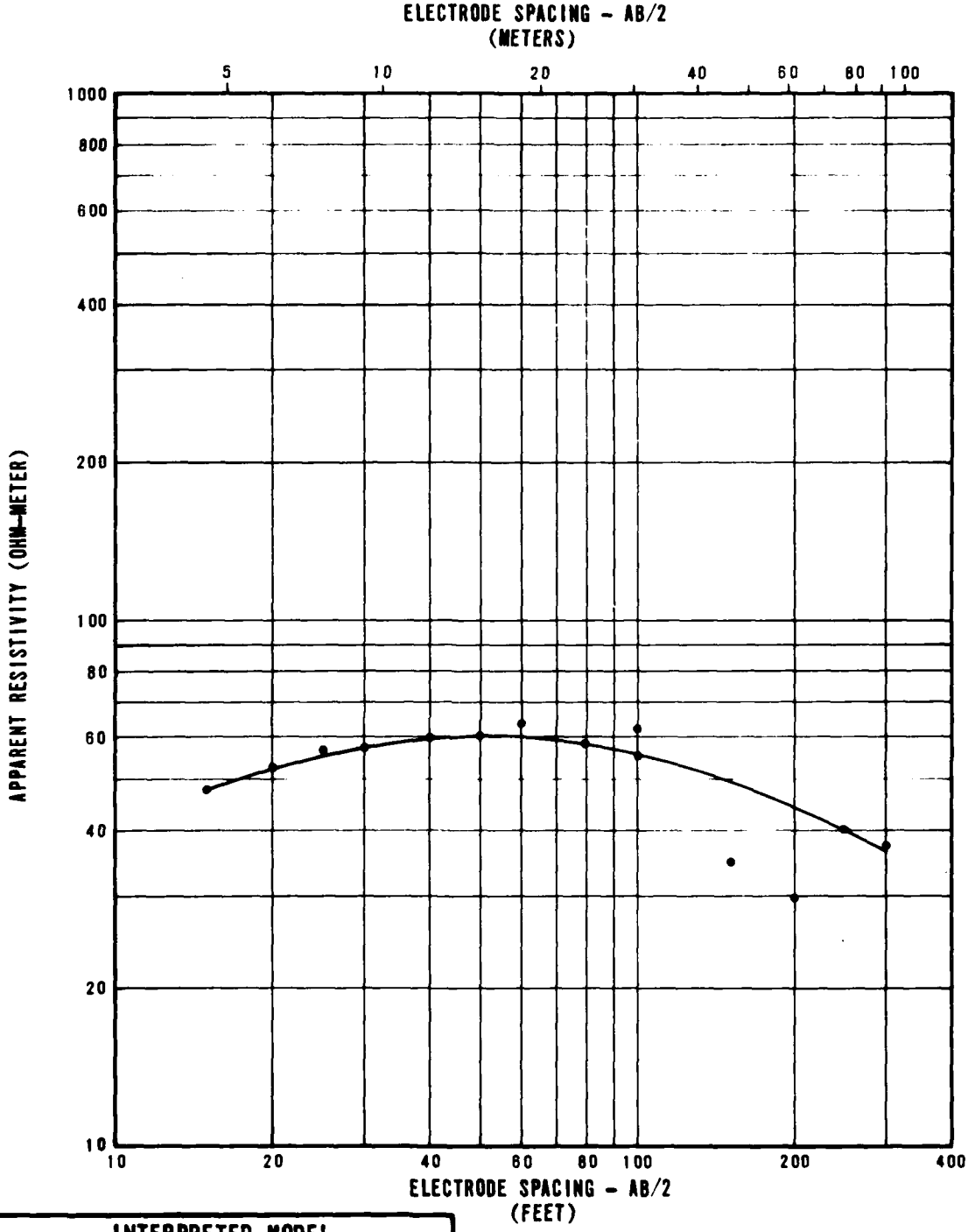
INTERPRETED MODEL		
LAYER DEPTH		RESISTIVITY VALUES
FEET	METERS	OHM-METER
0	0	70
25	8	360
156	48	40

RESISTIVITY SOUNDING BU-R-10
SOUNDING CURVE AND INTERPRETATION
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

FIGURE 4-9

FUGRO NATIONAL, INC.



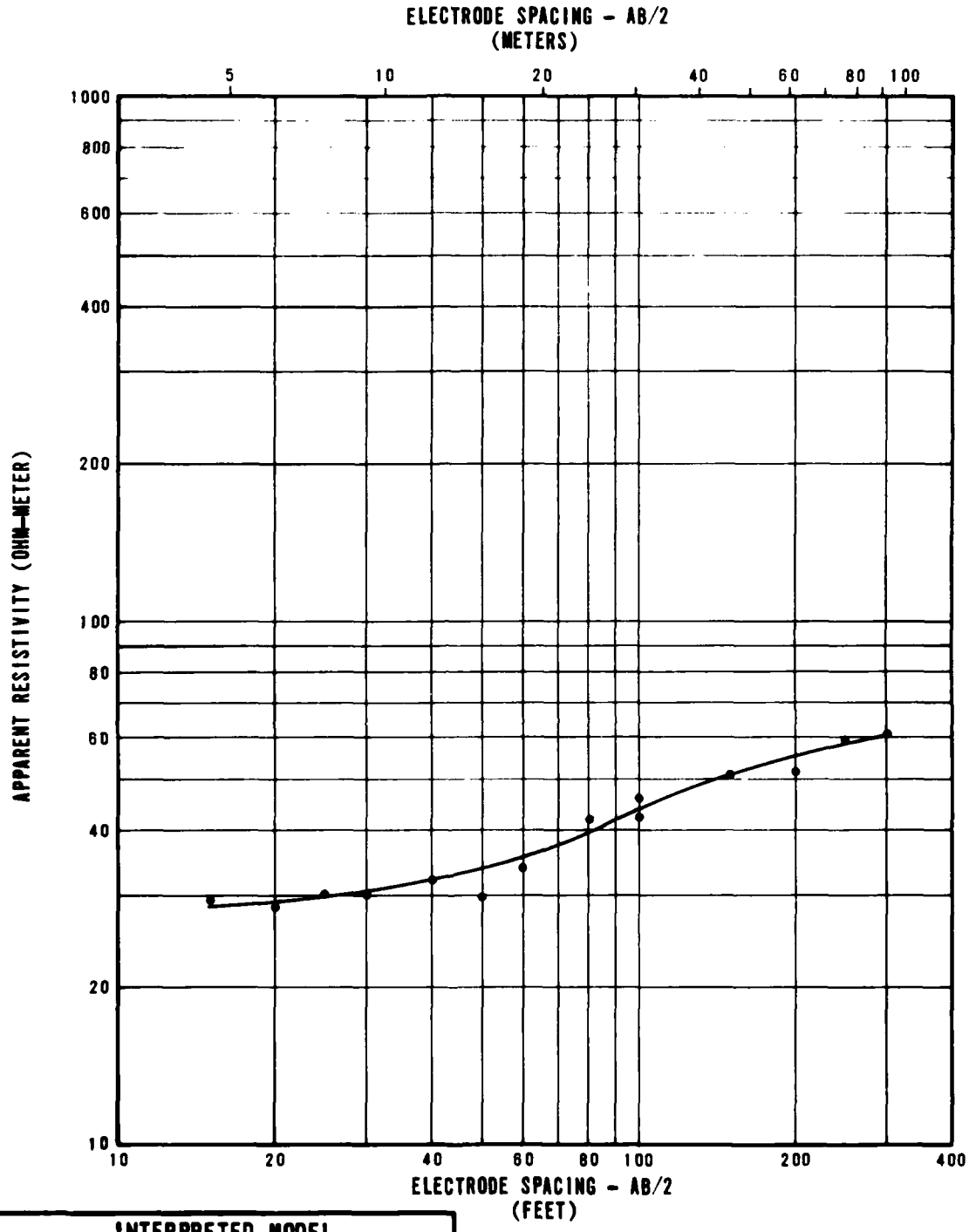
INTERPRETED MODEL		
LAYER DEPTH		RESISTIVITY VALUES
FEET	METERS	OHM-METER
0	0	45
12	4	85
48	15	30

RESISTIVITY SOUNDING BU-R-11
SOUNDING CURVE AND INTERPRETATION
VERIFICATION SITE, BUTLER COP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

FIGURE
4-10

FUGRO NATIONAL, INC.



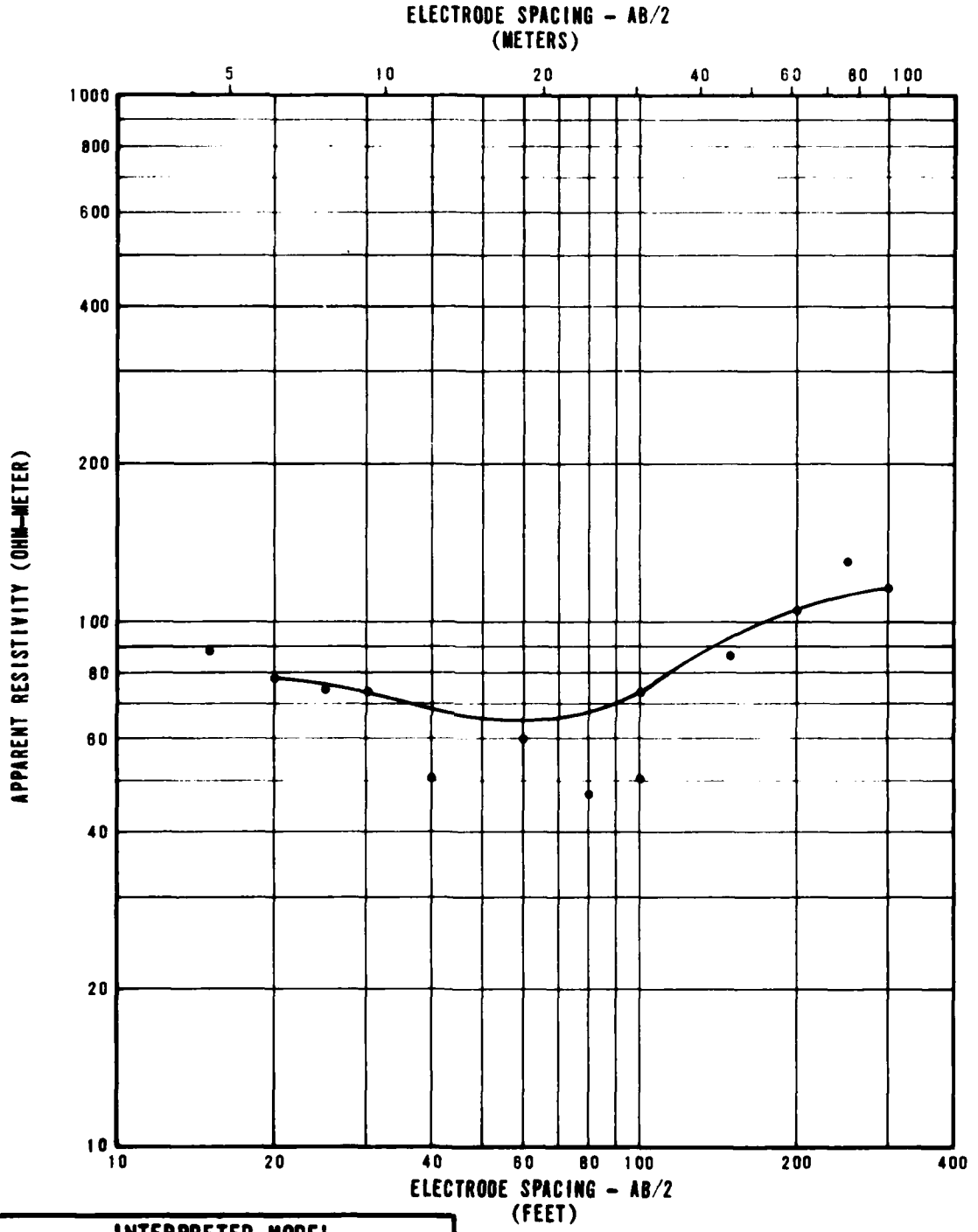
INTERPRETED MODEL		
LAYER DEPTH		RESISTIVITY VALUES
FEET	METERS	OHM-METER
0	0	30
30	9	70

RESISTIVITY SOUNDING BU-R-12
SOUNDING CURVE AND INTERPRETATION
VERIFICATION SITE, BUTLER COP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

FIGURE 4-11

FUGRO NATIONAL, INC.



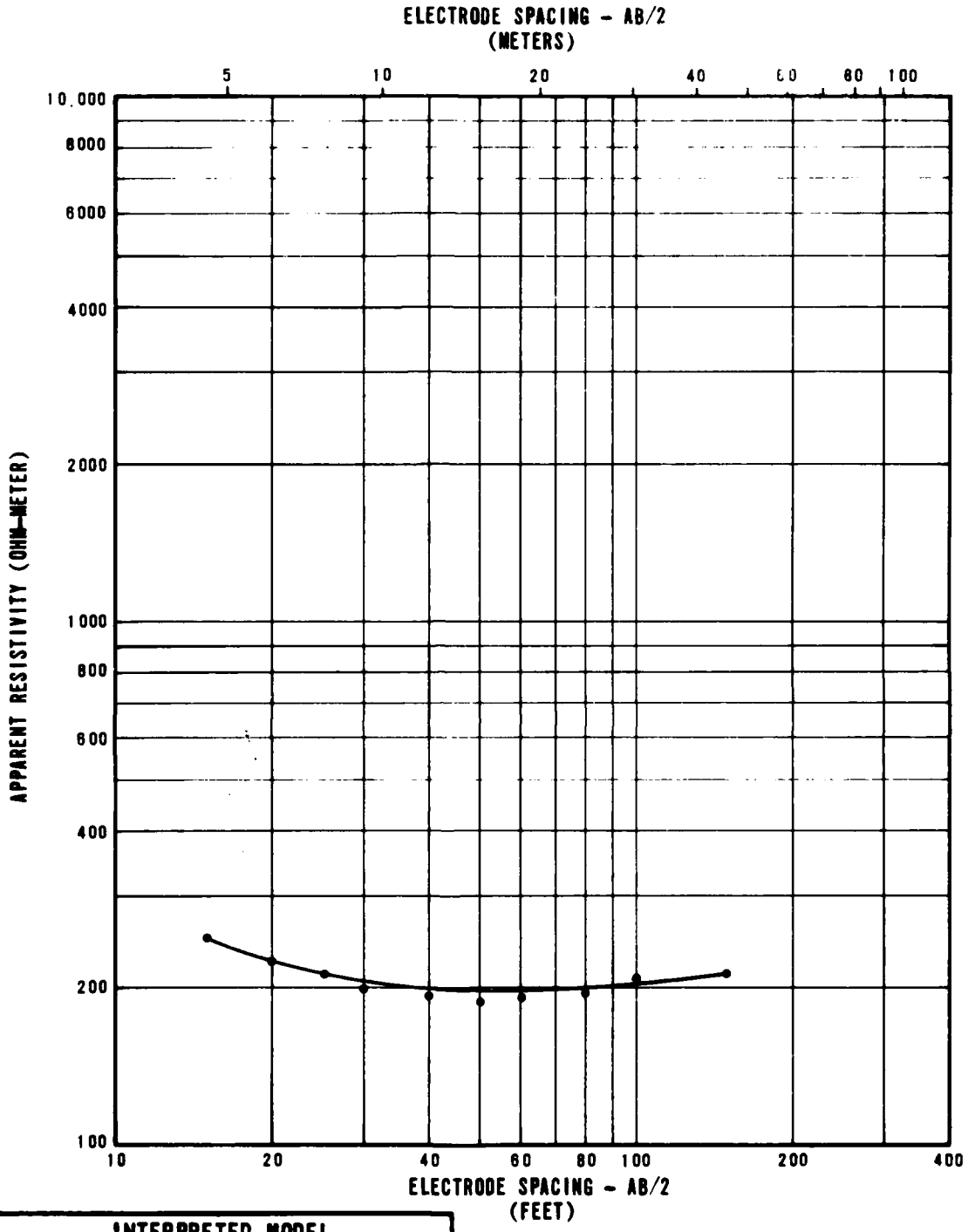
INTERPRETED MODEL		
LAYER DEPTH		RESISTIVITY VALUES
FEET	METERS	OHM-METER
0	0	95
12	4	55
65	20	170

RESISTIVITY SOUNDING BU-R-13
SOUNDING CURVE AND INTERPRETATION
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

FIGURE 4-12

FUGRO NATIONAL, INC.



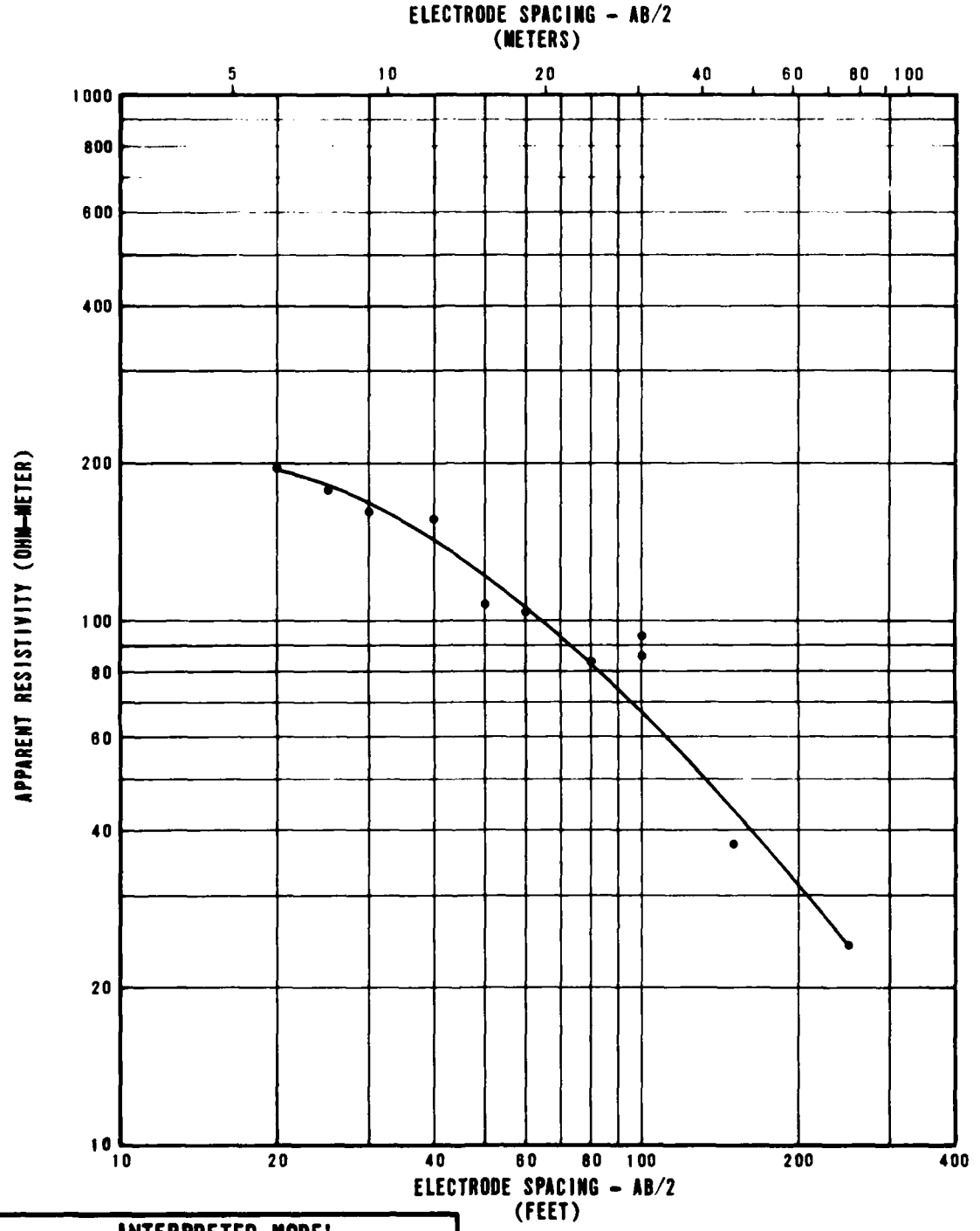
INTERPRETED MODEL		
LAYER DEPTH		RESISTIVITY VALUES
FEET	METERS	OHM-METER
0	0	25
8	2	18
40	12	25

RESISTIVITY SOUNDING BU-R-14
SOUNDING CURVE AND INTERPRETATION
VERIFICATION SITE, BUTLER COP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

FIGURE
4-13

FUGRO NATIONAL, INC.



INTERPRETED MODEL		
LAYER DEPTH		RESISTIVITY VALUES
FEET	METERS	OHM-METER
0	0	2[illegible]
22	7	55
110	34	11

RESISTIVITY SOUNDING BU-R-15
SOUNDING CURVE AND INTERPRETATION
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

FIGURE 4-14

FUGRO NATIONAL, INC.

SECTION 5.0

GRAVITY DATA

EXPLANATIONS OF GRAVITY DATA

Gravity data were not available in time (prior to June 1979) for incorporation into this report. A supplemental report containing gravity data and results will be issued at a later date.

SECTION 6.0

BORING LOGS

EXPLANATIONS OF BORING, TRENCH, AND TEST PIT LOGS

All data from borings, trenches, and test pits are presented on standard Fugro National logs in Sections 6.0 and 7.0. The following explanations are provided as a key to the logs.

A. Designations - Borings, trenches, and test pits are identified as follows:

BU-B-1
BU - abbreviation for the site (e.g., BU-Butler)
B - abbreviation for activity (e.g., B-boring, T-trench, P-test pit)
1 - number of activity

B. Sample Type - Different sampling techniques were used and the symbols are explained at the bottom of the boring logs. For details of sampling techniques, see Section A5.0 of Appendix A in Volume I. Horizontal lines, to scale, indicate the depth where sampling was attempted.

C. Percent Recovery - The numbers shown represent the ratio (in percent) of the soil sample recovered in the sampler to the full penetration of the sampler.

D. N Value - Corresponds to standard penetration resistance, which is number of blows required to drive a standard split-spoon sampler for the second and third of three 6-inch (15 cm) increments with a 140-pound (63.5 kg) hammer falling 30 inches (76 cm) (ASTM D 1586-67).

E. Depth - Corresponds to depth below ground surface in meters and feet.

F. Lithology - Graphic representation of the soil and rock types.

G. USCS - Unified Soil Classification System (see Table 6-1 for complete details) symbols.

H. Soil Description - Except in cases where samples were classified based on laboratory test data, the descriptions are based on visual classification. The procedures outlined in ASTM D 2487-69, Classification of Soils for Engineering Purposes, and D 2488-69, Description of Soils (Visual-Manual Procedure) were followed. Solid lines across the column indicate known change in strata at the depth shown.

Definitions of some of the terms and criteria to describe soils and conditions encountered during the exploration follow.

Gradation : A coarse-grained soil is well graded if it has a wide range in grain size and substantial amounts of most intermediate particle sizes.

Poorly graded indicates that the soil consists predominantly of one size (uniformly graded) or has a wide range of sizes with some intermediate sizes obviously missing (gap-graded).

Moisture :

Dry	- no feel of moisture
Slightly Moist	- much less than normal moisture
Moist	- normal moisture for soil
Very Moist	- much greater than normal moisture
Wet	- for soils below the water table (if known)

10 MAR 70

FM-TR-28-11

UNIFIED SOIL CLASSIFICATION SYSTEM

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE 0-1

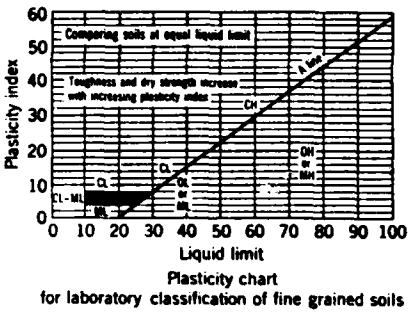
FUNDAMENTALS

Field Identification Procedures (Excluding particles larger than 3 in. and basing fractions on estimated weights)						Group Symbols [a]	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria
Coarse-grained soils: More than half of material is larger than No. 200 sieve size [b] (The No. 200 sieve size is about the smallest particle visible to naked eye)	Gravels: More than half of coarse fraction is larger than No. 4 sieve size (For visual classification, the ¼ in. size may be used as equivalent to the No. 4 sieve size)	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes			GW	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbols in parentheses For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics Example: *Silty sand*, gravelly; about 20% hard, angular gravel particles ½-in. maximum size; rounded and subangular sand grains coarse to fine, about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; (*SM*)	$C_U = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or a range of sizes with some intermediate sizes missing			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for *GW*
		Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)			GM	Silty gravels, poorly graded gravel-sand-silt mixtures		Atterberg limits below "A" line, or *PI* less than 4 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
			Plastic fines (for identification procedures, see *CL* below)			GC	Clayey gravels, poorly graded gravel-sand-clay mixtures		Atterberg limits above "A" line, with *PI* greater than 7
	Sands: More than half of coarse fraction is smaller than No. 4 sieve size (For visual classification, the ¼ in. size may be used as equivalent to the No. 4 sieve size)	Clean sands (little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes			SW	Well graded sands, gravelly sands, little or no fines		$C_U = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or a range of sizes with some intermediate sizes missing			SP	Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for *SW*
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures, see *ML* below)			SM	Silty sands, poorly graded sand-silt mixtures		Atterberg limits below "A" line or *PI* less than 4 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
			Plastic fines (for identification procedures, see *CL* below)			SC	Clayey sands, poorly graded sand-clay mixtures		Atterberg limits below "A" line with *PI* greater than 7
Fine-grained soils: More than half of material is smaller than No. 200 sieve size (The No. 200 sieve size is about the smallest particle visible to naked eye)	Identification Procedures on Fraction Smaller than No. 40 Sieve Size								
	Silts and clays: Liquid limit less than 50	Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)					
		None to slight	Quick to slow	None		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions Example: *Clayey silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (*ML*)	
		Medium to high	None to very slow	Medium		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays		
		Slight to medium	Slow	Slight		OL	Organic silts and organic silt-clays of low plasticity		
	Silts and clays: Liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts		
		High to very high	None	High		CH	Inorganic clays of high plasticity, fat clays		
		Medium to high	None to very slow	Slight to medium		OH	Organic clays of medium to high plasticity		
Highly Organic Soils		Readily identified by colour, odour, spongy feel and frequently by fibrous texture				Pt	Peat and other highly organic soils		

Use grain size curve in identifying the fractions as given under field identification

Determine percentages of gravel and sand from grain size curve

Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follows:
Less than 5% — *GW, GP, SW, SP*
More than 12% — *GM, GC, SM, SC*
5% to 12% — *Borderline* cases requiring use of dual symbols



Plasticity chart
for laboratory classification of fine grained soils

From Wagner, 1957.

[a] *Boundary classifications*. Soils possessing characteristics of two groups are designated by combinations of group symbols. For example *GW-GC*, well graded gravel-sand mixture with clay binder.

[b] All sieve sizes on this chart are U.S. standard.

Field Identification Procedure for Fine Grained Soils or Fractions

These procedures are to be performed on the minus No. 40 sieve size particles, approximately ¼₆ in. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Dilatancy (Reaction to shaking):

After removing particles larger than No. 40 sieve size, prepare a pat of moist soil with a volume of about one-half cubic inch. Add enough water if necessary to make the soil soft but not sticky.

Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.

Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

Dry Strength (Crushing characteristics):

After removing particles larger than No. 40 sieve size, mould a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.

High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

Toughness (Consistency near plastic limit):

After removing particles larger than the No. 40 sieve size, a specimen of soil about one-half inch cube in size, is moulded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about one-eight inch in diameter. The thread is then folded and re-rolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.

After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles.

The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line.

Highly organic clays have a very weak and spongy feel at the plastic limit.

Consistency: Consistency descriptions of coarse-grained soils (GW, GP, GM, GC, SW, SP, SM, SC) are as follows.

Consistency	N Value (ASTM D 1586-67)
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	>50

Consistency descriptions of fine-grained soils (ML, CL, MH, CH,) are as follows:

Consistency	Shear Strength (ksf)	Shear Strength (kn/m^2)	Field Guide
Very Soft	0.25	12	Sample with height equal to twice the diameter, sags under own weight
Soft	0.25-0.50	12 - 24	Can be squeezed between thumb and forefinger
Firm	0.50-1.00	24-48	Can be molded easily with fingers
Stiff	1.00-2.00	48-96	Can be imprinted with slight pressure from fingers
Very Stiff	2.00-4.00	96-192	Can be imprinted with considerable pressure from fingers
Hard	over 4.00	over 192	Cannot be imprinted by fingers

Grain Shape: Angular - particles have sharp edges and relatively plane sides with unpolished surfaces.

Subangular - particles are similar to angular but have somewhat rounded edges.

Subrounded - particles exhibit nearly plane sides but have well-rounded corners and edges.

Rounded - particles have smoothly curved sides and no edges.

Calcareous : Containing calcium carbonate; presence of calcium carbonate is commonly identified on the basis of reaction with dilute hydrochloric acid.

Caliche : Soils cemented by porous calcium carbonate and/or other soluble minerals by upward-moving solutions.

Degree of Cementation: (Stages of development of caliche profile)

Stage	Gravelly Soils	Nongravelly Soils
I	Thin, discontinuous pebble coatings	Few filaments or faint coatings
II	Continuous pebble coatings, some interpebble fillings	Few to abundant nodules, flakes, filaments
III	Many interpebble fillings	Many nodules and internodular fillings
IV	Laminar horizon overlying plugged horizon	Increasing carbonate impregnation

Secondary Material : Example - Sand with trace to some silt

Trace - 5-12% (by dry weight)
Little - 13-20% (by dry weight)
Some - >20% (by dry weight)

Plasticity : Plasticity index is the range of water content, expressed as a percentage of the weight of the oven-dried soil, through which the soil is plastic. It is defined as the liquid limit minus the plastic limit. Descriptive ranges used on the logs include:

Nonplastic	(PI, 0 - 4)
Slightly Plastic	(PI, 4 - 15)
Medium Plastic	(PI, 15 - 30)
Highly Plastic	(PI, >30)

Cobbles and Boulders : A cobble is a rock fragment, usually rounded by weathering or abrasion, with an average diameter ranging between 3 and 12 inches (8 and 30 cm).

A boulder is a rock fragment, usually rounded by weathering or abrasion, with an average diameter of 12 inches (30 cm) or more.

I. Remarks - This column was provided on boring and trench logs for comments regarding drilling difficulty, number and size of cobbles or boulders encountered, trench wall stability, loss of drilling fluid in the boring, and other conditions encountered during drilling and excavations.

J. Dry Density and Moisture Content - The boring logs include a graphical display of laboratory test results for dry density (ASTM D 2937-71) in pounds per cubic foot and kilograms cubic meter and moisture content (ASTM D 2216-71) in percent from representative samples taken during drilling. The symbols are explained at the bottom of the boring logs.

K. Seive Analysis - The numbers represent the percentage by dry weight (ASTM D 422-63) of each of the following soil components:

GR - Gravel, rock particles that will pass a 3-inch (76 mm) sieve and are retained on No. 4 (4.75 mm) sieve.

SA - Sand, soil particles passing No. 4 sieve and retained on No. 200 (0.075 mm) sieve.

FI - Fines, silt or clay, soil particles passing No. 200 sieve.

L. Atterberg Limits (LL and PI) -

LL - Liquid Limit, the water content corresponding to the arbitrary limit between the liquid and plastic states of consistency of a soil (ASTM D 423-66).

PL - Plastic Limit, the water content corresponding to an arbitrary limit between the plastic and the semisolid state of consistency of a soil (ASTM D 424-59).

PI - Plasticity Index, numerical difference between the liquid limit (LL) and the plastic limit (PL) indicating the range of moisture content within which a soil-water mixture is plastic.

NP - Nonplastic.

M. Miscellaneous Information -

Elevations - indicated elevations on the logs are estimated from topographic maps of the study area, within an accuracy of half the contour interval.

Surficial Geologic Unit - indicates the surficial geologic unit in which the activity is located.

Date Drilled - indicates the period from beginning to completion of the activity.

Drilling Method - signifies the type of drilling procedure used such as rotary wash.

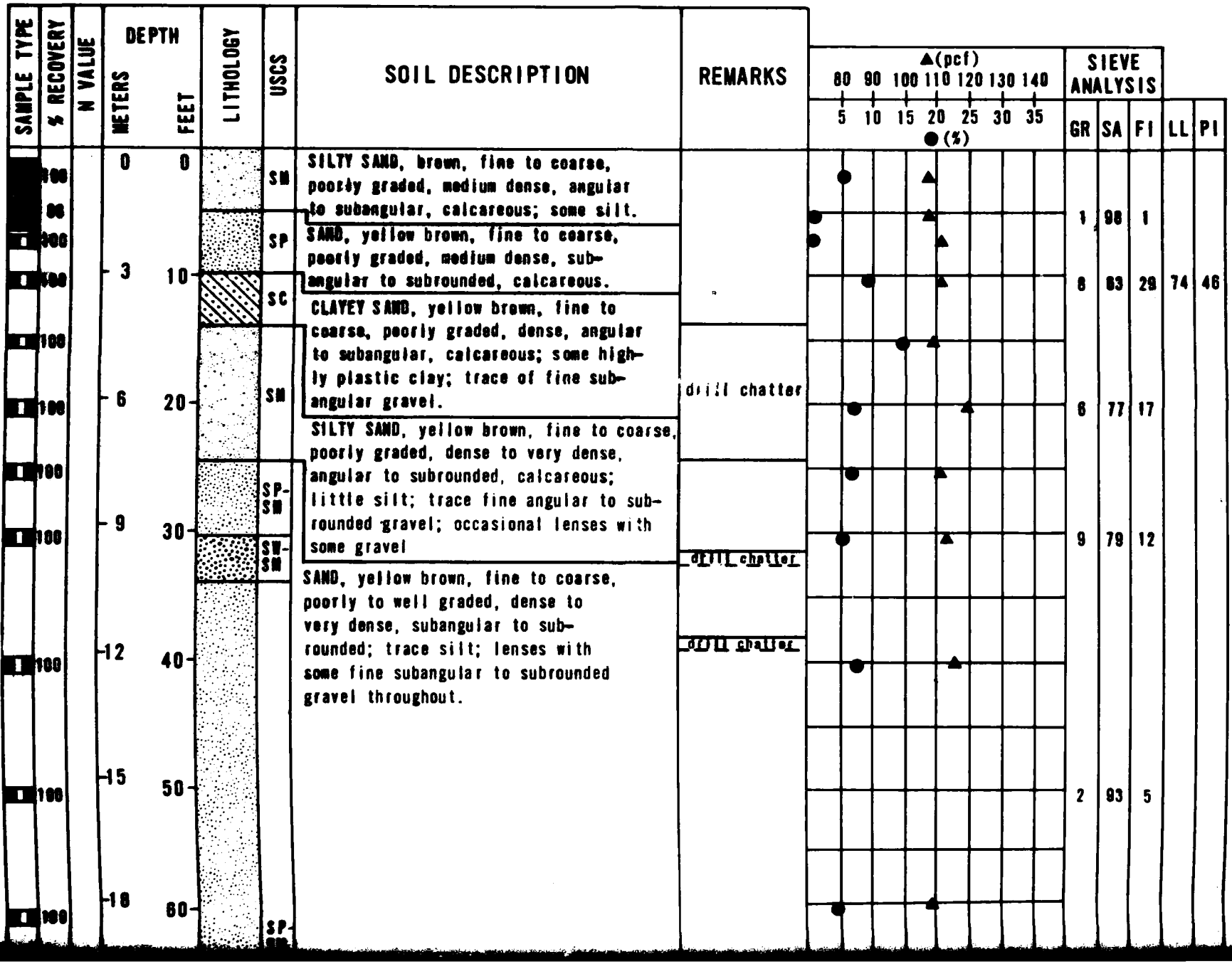
Hole Diameter - nominal size of boring drilled.

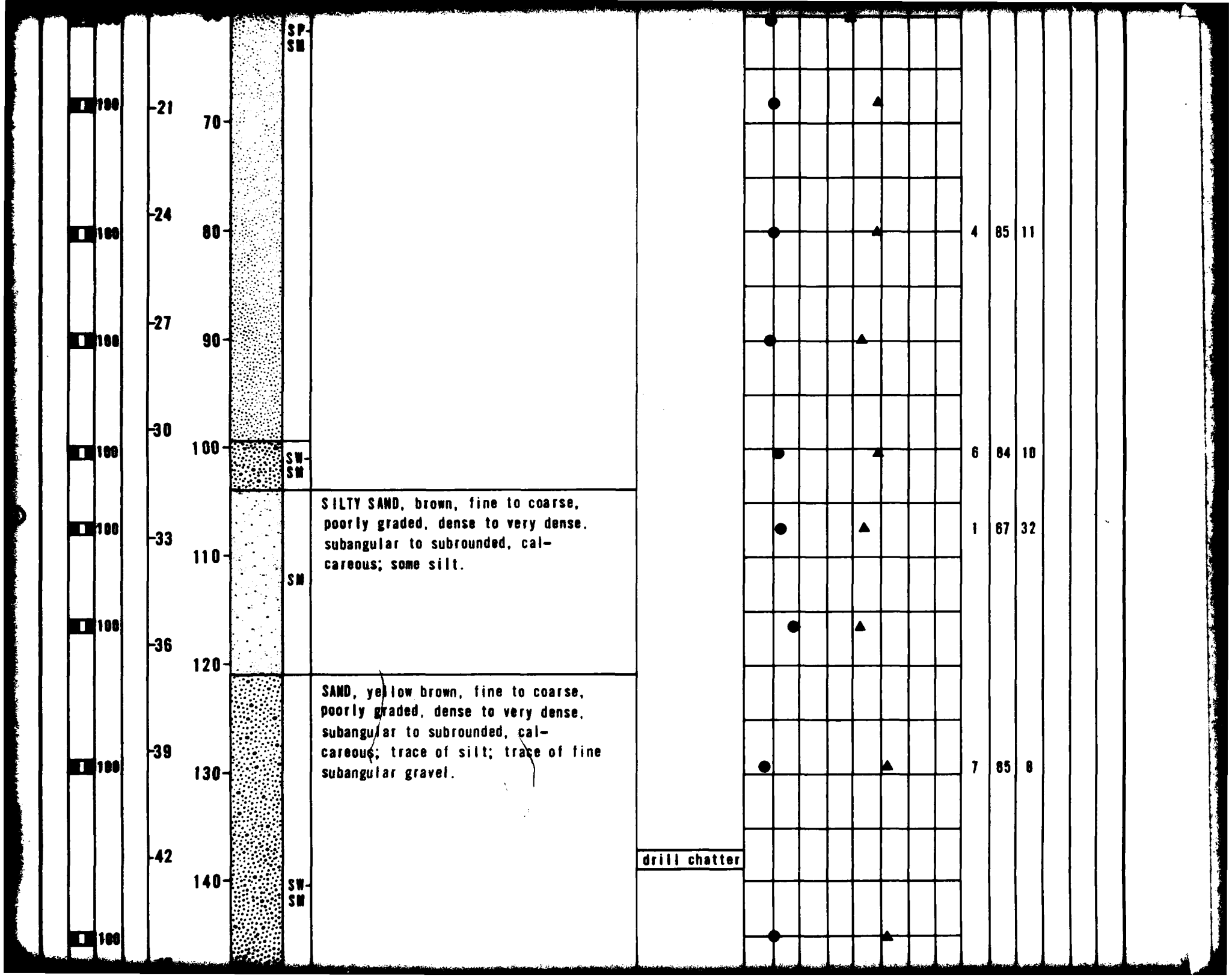
Water Level - indicates depth from ground surface to water table where encountered.

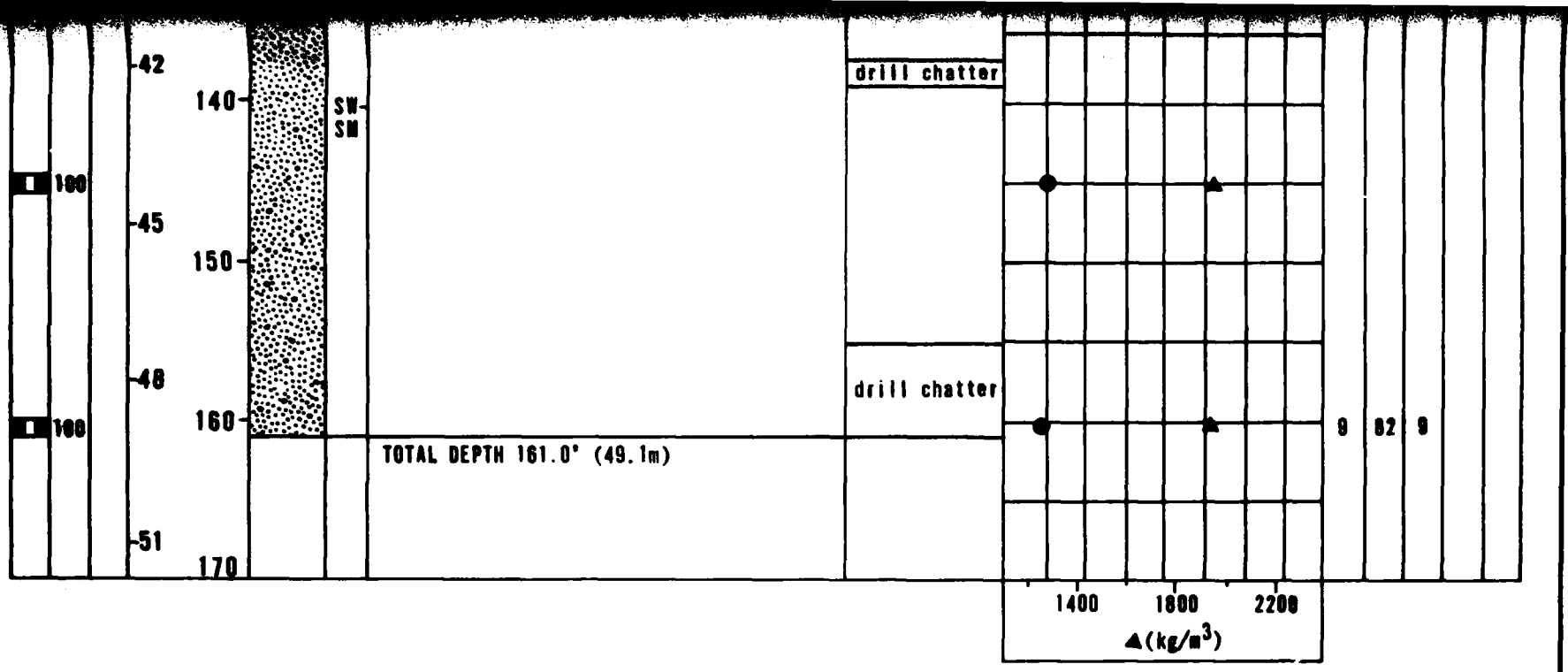
Trench Length - length at ground surface of final trench excavation.

Trench Orientation - bearing of longitudinal trench centerline.

CHECKED BY _____ APPROVED BY _____




SP-SM
SW-SM
SM
SW-SM
SILTY SAND, brown, fine to coarse, poorly graded, dense to very dense, subangular to subrounded, calcareous; some silt.
SAND, yellow brown, fine to coarse, poorly graded, dense to very dense, subangular to subrounded, calcareous; trace of silt; trace of fine subangular gravel.
drill chatter
70
80
90
100
110
120
130
140
21
24
27
30
33
36
39
42
4 85 11
6 84 10
1 67 32
7 85 8



EXPLANATION

- FUGRO DRIVE SAMPLE
- BULK SAMPLE
- PITCHER TUBE SAMPLE
- STANDARD PENETRATION TEST SAMPLE
- CORE SAMPLE
- N - STANDARD PENETRATION RESISTANCE
- ▲ - DRY UNIT WEIGHT (ASTM: D-2937-71)
- ● - MOISTURE CONTENT (ASTM: D-2216-71)
- NR - NO RECOVERY

BORING DETAILS

ELEVATION	: 1925' (587m)
SURFICIAL GEOLOGIC UNIT	: A5y
DATE DRILLED	: 7 March 1979
DRILLING METHOD	: Rotary Wash
HOLE DIAMETER	: 4 7/8" (124mm)
WATER LEVEL	: Not Encountered

LOG OF BORING MW-B-1
VERIFICATION SITE, BUTLER COP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

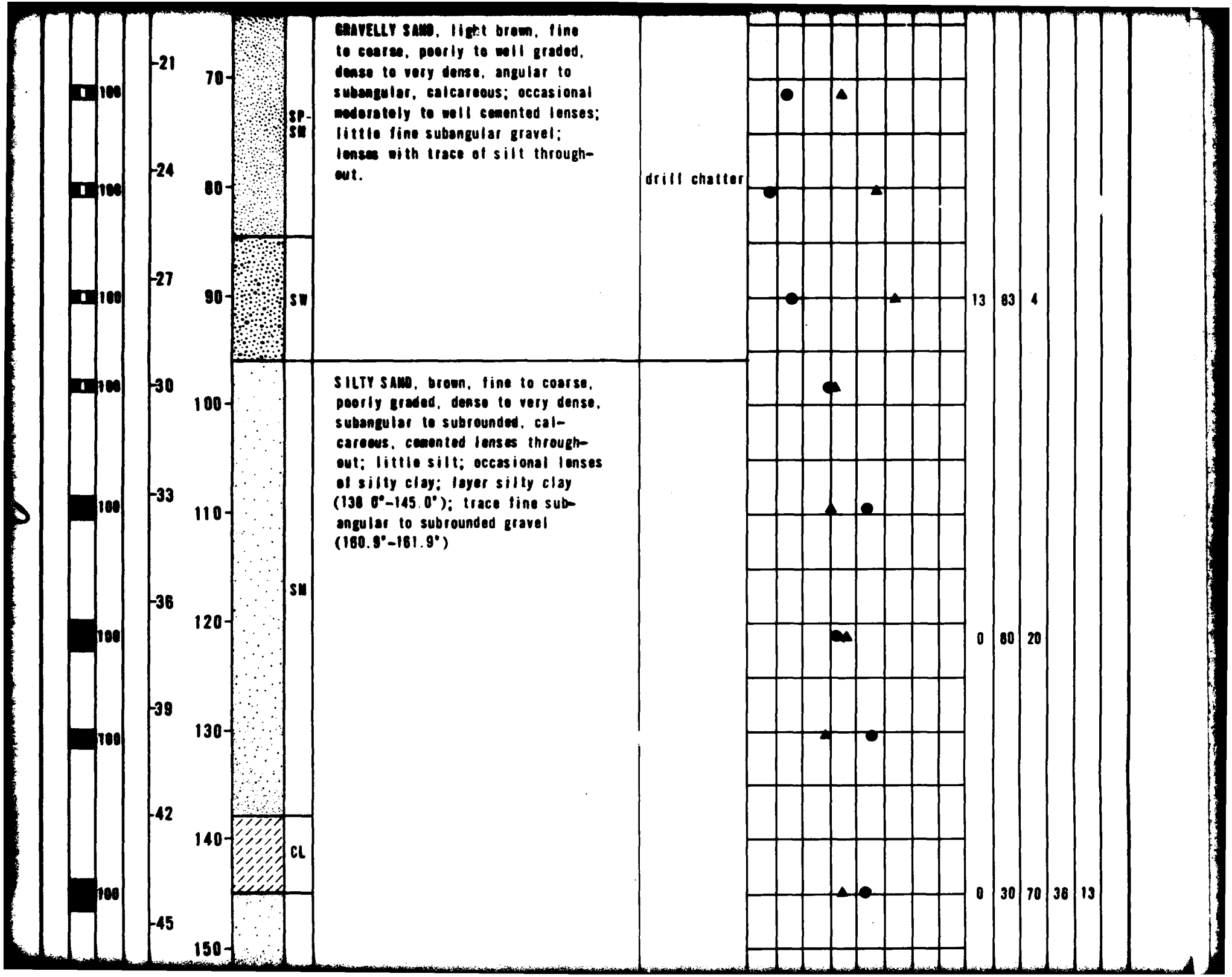
FIGURE B-1

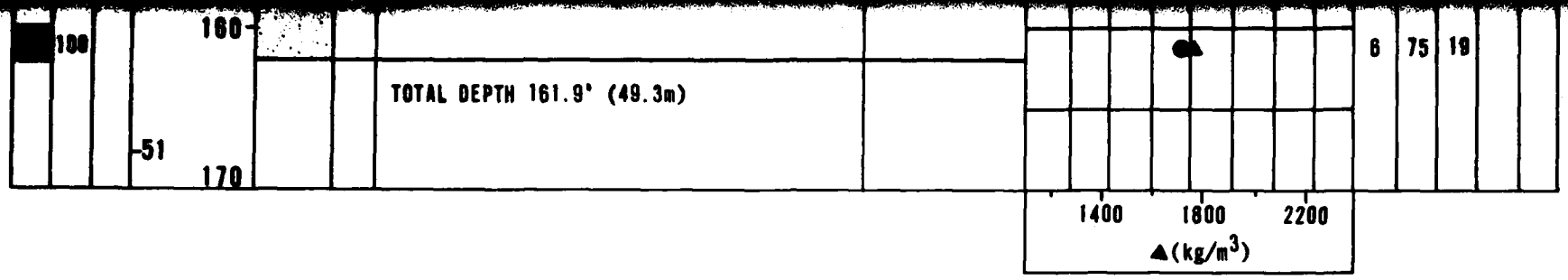
CONSULTANTS INC.

CHECKED BY _____ APPROVED BY _____

FN-TR-28-11

SAMPLE TYPE	% RECOVERY	N VALUE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	SOIL DESCRIPTION	REMARKS	▲(pcf) 80 90 100 110 120 130 140 / ●(%) 5 10 15 20 25 30 35	SIEVE ANALYSIS GR	SA	FI	LL	PI
	98		0	0		SM	GRAVELLY SAND, yellow brown, fine to coarse, poorly to well graded, medium dense to dense, subangular to subrounded, calcareous; little fine to coarse subangular gravel; trace of silt, layer of silty sand (0.0'–3.0')	drill chatter		15	77	8		
	100					SW-SM								
	100					SP-SM								
	100		3	10		SM	SILTY SAND, brown, fine to coarse, poorly graded, dense, subangular, some silt.			3	67	30		
	100		6	20		ML	SANDY SILT, brown, hard, nonplastic, calcareous; little fine to coarse sand.			0	20	80		
	100		9	30						0	13	87		
	100		12	40		SP-SM	GRAVELLY SAND, brown, fine to coarse, poorly graded, very dense, angular to subangular, calcareous; some fine angular to subangular gravel; trace silt; layer silty sand (40.5'–42.5')	drill chatter		27	68	5		
	100					SM				0	58	42		
	100					SP-SM								
	100		15	50		SM	SILTY SAND, brown, fine to coarse, poorly graded, very dense, subangular to subrounded, calcareous; well cemented 50'–54; some silt; lenses of sandy silt throughout.			2	67	31		
	100		18	60										


100
100
100
100
100
100
100
21
24
27
30
33
36
39
42
45
70
80
90
100
110
120
130
140
150
SP-SM
SW
SM
CL
GRAVELLY SAND, light brown, fine to coarse, poorly to well graded, dense to very dense, angular to subangular, calcareous; occasional moderately to well cemented lenses; little fine subangular gravel; lenses with trace of silt throughout.
drill chatter
SILTY SAND, brown, fine to coarse, poorly graded, dense to very dense, subangular to subrounded, calcareous, cemented lenses throughout; little silt; occasional lenses of silty clay; layer silty clay (138.0'-145.0'); trace fine subangular to subrounded gravel (160.9'-161.9')
13 83 4
0 80 20
0 30 70 36 13



EXPLANATION

- FUGRO DRIVE SAMPLE
- BULK SAMPLE
- PITCHER TUBE SAMPLE
- STANDARD PENETRATION TEST SAMPLE
- CORE SAMPLE
- N - STANDARD PENETRATION RESISTANCE
- ▲ - DRY UNIT WEIGHT (ASTM: D-2937-71)
- ● - MOISTURE CONTENT (ASTM: D-2216-71)
- NR - NO RECOVERY

BORING DETAILS

ELEVATION	: 1350' (411m)
SURFICIAL GEOLOGIC UNIT	: A5i
DATE DRILLED	: 7 & 8 March 1979
DRILLING METHOD	: Rotary Wash
HOLE DIAMETER	: 4 7/8" (124mm)
WATER LEVEL	: Not Encountered

FUGRO NATIONAL, INC.

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE 6-2

LOG OF BORING MU-6-2
VERIFICATION SITE, BUTLER COP, ARIZONA

AEV-06

CHECKED BY _____ APPROVED BY _____

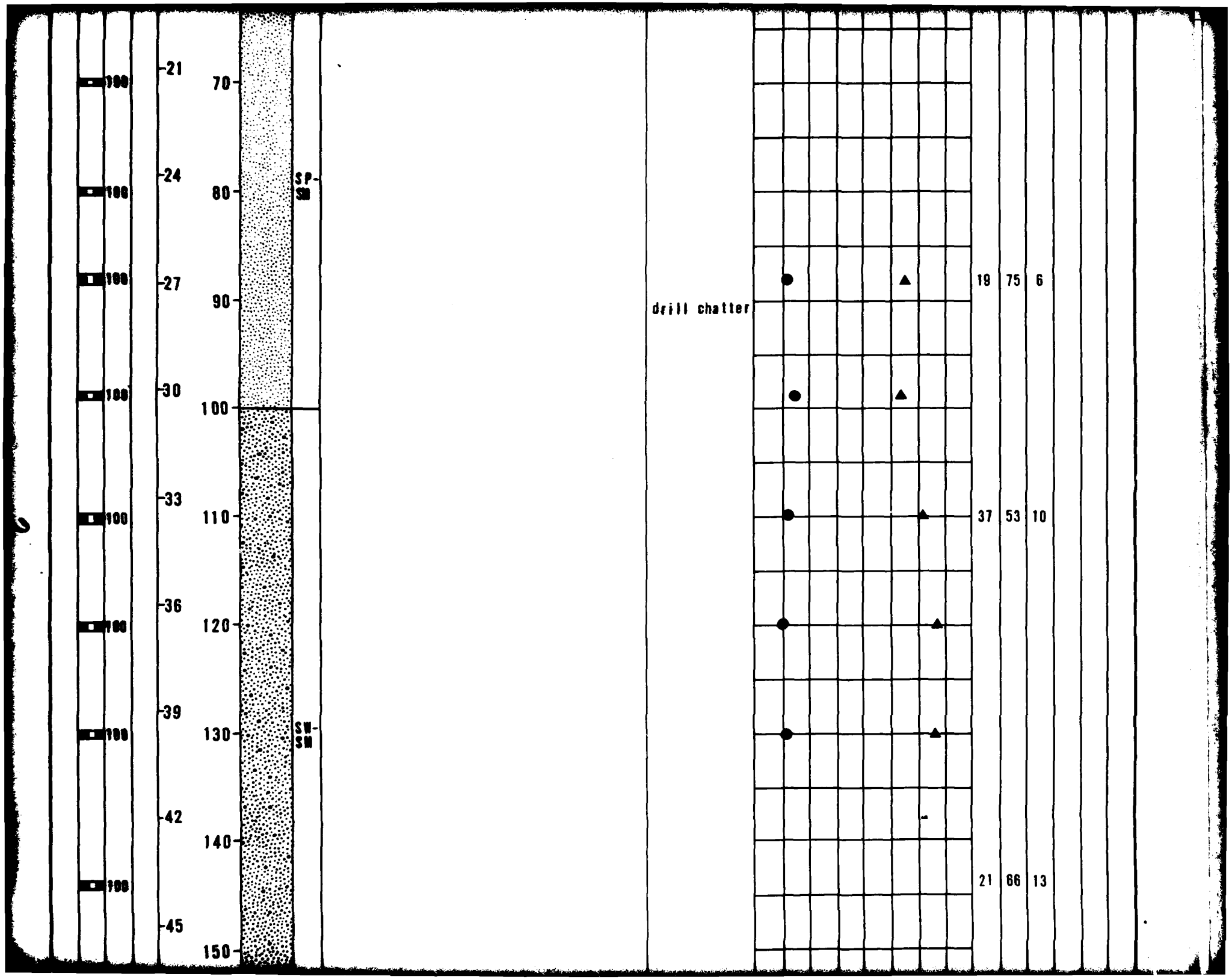
FN-TR-28-11

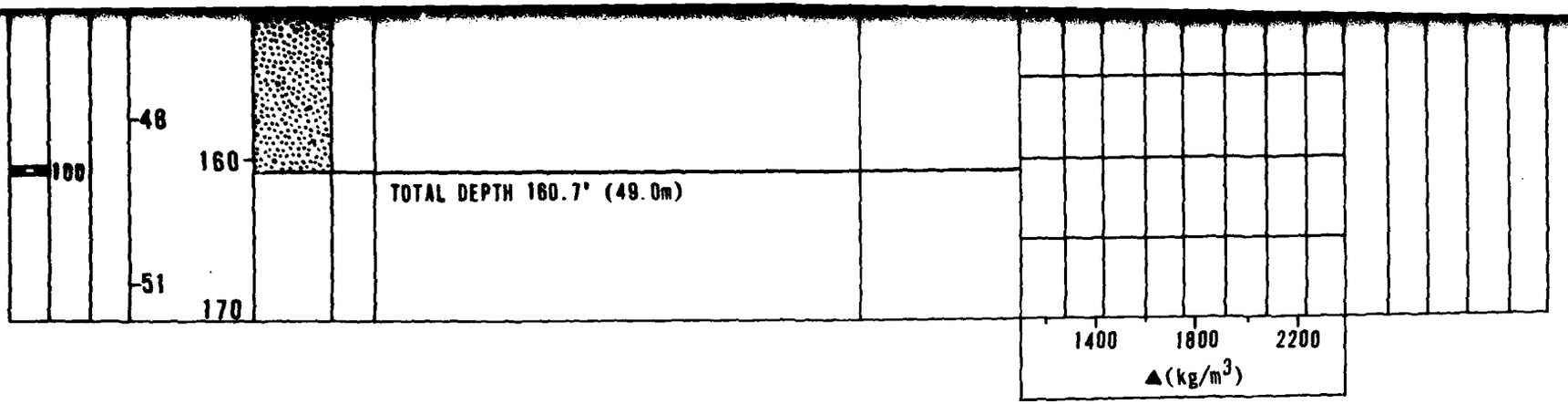
SAMPLE TYPE	% RECOVERY	N VALUE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	SOIL DESCRIPTION	REMARKS	GR	SA	FI	LL	PI
	100		0	0		SM	GRAVELLY SAND, light brown, fine to coarse, poorly to well graded, medium dense to very dense, angular to subrounded, calcareous; some fine to coarse angular to subrounded gravel; trace silt; occasional cobbles throughout; layer of clayey sand (27.0'-32.5'); occasional lenses of silty sand (32.5'-47.0'); layers of silty sand (0.0'-4.0') and (47.0'-50.0').	drill chatter					
	100												
	80					SP-SM			44	48	8		
	73		3	10		SW-SM							
	100								40	50	10		
	100		6	20		SP-SM							
	100					SW-SM			46	48	6		
	100		9	30		SC			3	48	49	37	18
	100					SP-SM							
	100		12	40					41	53	6		
	100		15	50		SM			16	49	35		
						SP-SM							
	100		18	60		SW-SM			24	65	11		

▲(pcf) 80 90 100 110 120 130 140

● (%) 5 10 15 20 25 30 35

SIEVE ANALYSIS


100
100
100
100
100
100
100
21
24
27
30
33
36
39
42
45
70
80
90
100
110
120
130
140
150
SP-SM
SW-SM
drill chatter
19 75 6
37 53 10
21 66 13



EXPLANATION

- FUGRO DRIVE SAMPLE
- BULK SAMPLE
- PITCHER TUBE SAMPLE
- STANDARD PENETRATION TEST SAMPLE
- CORE SAMPLE
- N – STANDARD PENETRATION RESISTANCE
- ▲ – DRY UNIT WEIGHT (ASTM: D-2937-71)
- ● – MOISTURE CONTENT (ASTM: D-2216-71)
- NR – NO RECOVERY

BORING DETAILS

ELEVATION	: 1930' (588m)
SURFICIAL GEOLOGIC UNIT	: A5y
DATE DRILLED	: 9 & 10 March 1979
DRILLING METHOD	: Rotary Wash
HOLE DIAMETER	: 4 7/8" (124mm)
WATER LEVEL	: Not Encountered

FUGRO NATIONAL, INC.

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE 6-3

LOG OF BORING BU-B-3
VERIFICATION SITE, BUTLER COP, ARIZONA

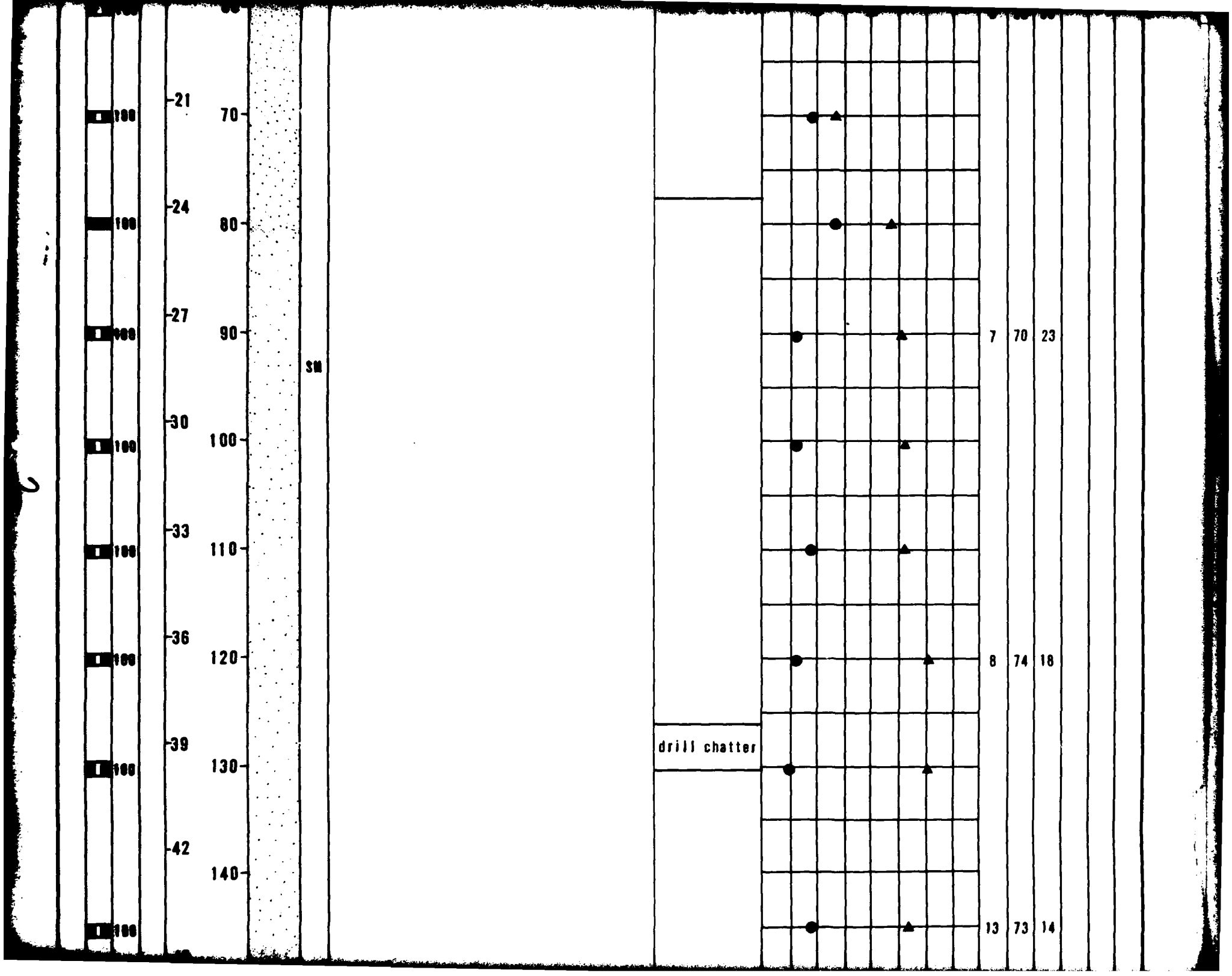
AFV-06

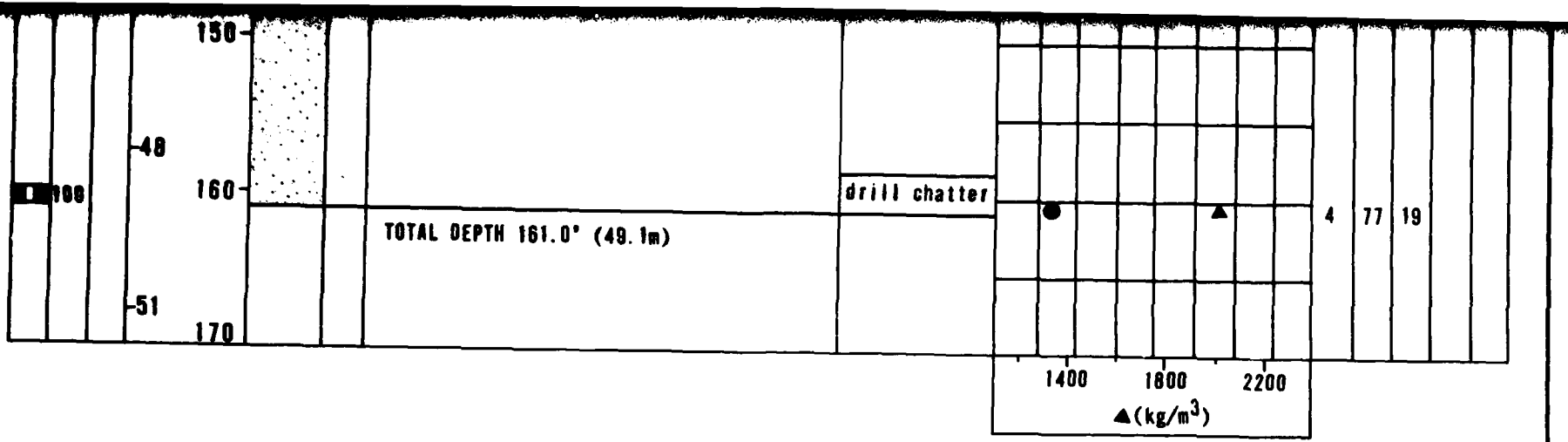
3

CHECKED BY _____ APPROVED BY _____

FN-TR-28-11

SAMPLE TYPE	% RECOVERY	N VALUE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	SOIL DESCRIPTION	REMARKS	▲(pcf) 80 90 100 110 120 130 140 / ●(%) 5 10 15 20 25 30 35	SIEVE ANALYSIS GR	SA	FI	LL	PI
	23		0	0			GRAVELLY SAND, light brown, fine to coarse, poorly to well graded, loose to very dense, angular to subangular, calcareous; trace to some fine to coarse angular to subrounded gravel; trace to some silt.							
	23					SM				41	42	17		
	100													
	100		3	10						21	52	27		
	100					SW-SM				10	81	9		
	100		6	20		SM		drill chatter						
	100					SC	CLAYEY SAND, light brown, fine to coarse, poorly graded, dense, angular to subangular, calcareous; cemented; some silty clay; little fine to coarse gravel.			18	56	26	46	26
	100		9	30						9	64	27		
							SILTY SAND, brown, fine to coarse, poorly graded, dense to very dense, angular to subangular, calcareous; frequent weakly to moderately cemented lenses (81.5'-127.0') and 142.0'-161.0'); little to some silt; trace to little fine to coarse angular to subangular gravel.							
	100		12	40										
	100		15	50										
	100		18	60				irregular drill chatter		8	59	33		


100
100
100
100
100
100
100
100
-21
-24
-27
-30
-33
-36
-39
-42
70
80
90
100
110
120
130
140
SM
drill chatter
7 70 23
8 74 18
13 73 14



EXPLANATION

- FUGRO DRIVE SAMPLE
- BULK SAMPLE
- PITCHER TUBE SAMPLE
- STANDARD PENETRATION TEST SAMPLE
- CORE SAMPLE
- N - STANDARD PENETRATION RESISTANCE
- ▲ - DRY UNIT WEIGHT (ASTM: D-2937-71)
- ● - MOISTURE CONTENT (ASTM: D-2216-71)
- NR - NO RECOVERY

BORING DETAILS

ELEVATION	: 1610' (491m)
SURFICIAL GEOLOGIC UNIT	: A5y
DATE DRILLED	: 10 & 11 March 1979
DRILLING METHOD	: Rotary Wash
HOLE DIAMETER	: 4 7/8" (124mm)
WATER LEVEL	: Not Encountered

LOG OF BORING BU-8-4
VERIFICATION SITE, BUTLER COP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE 8-4

FUGRO NATIONAL, INC.

AFV-08

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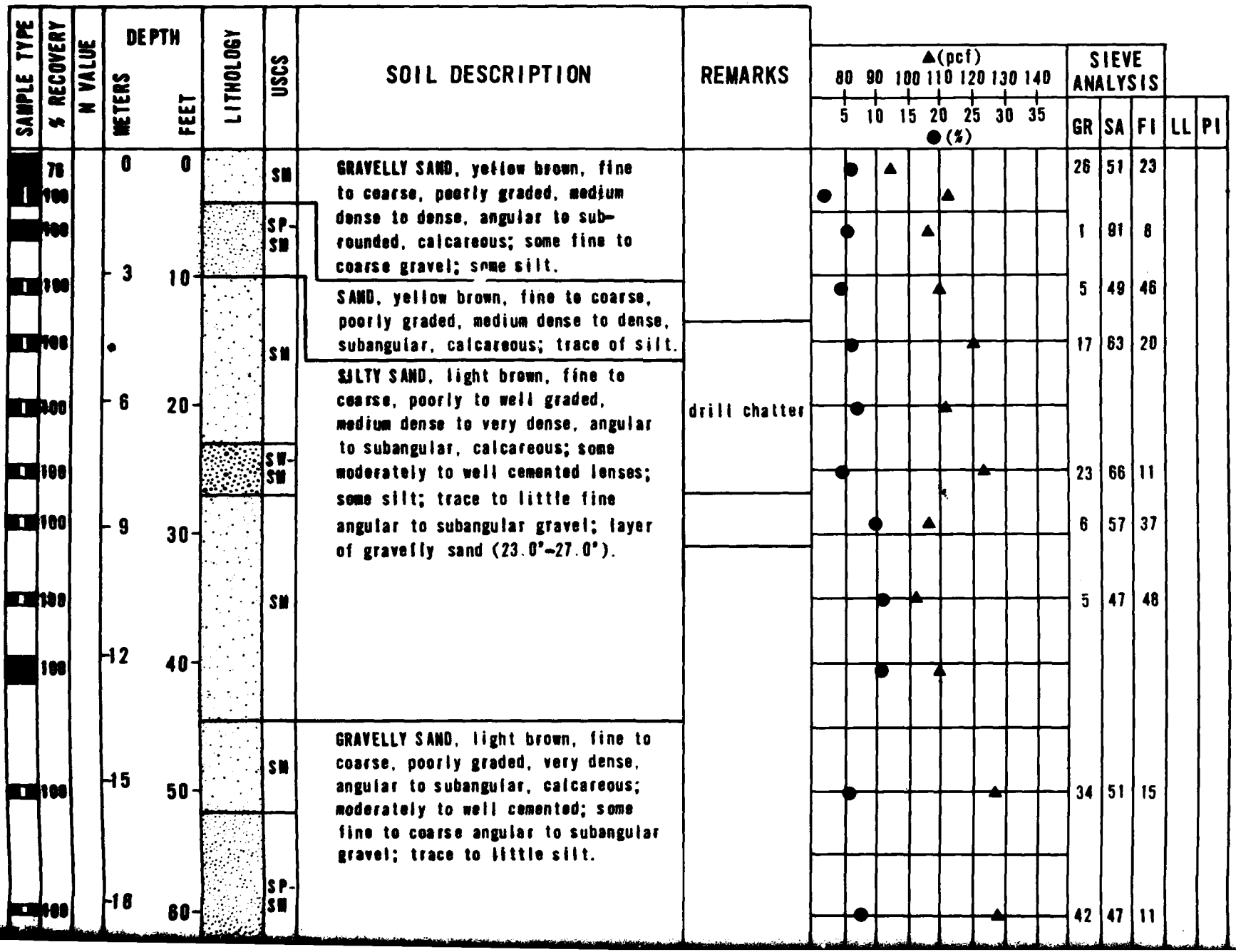
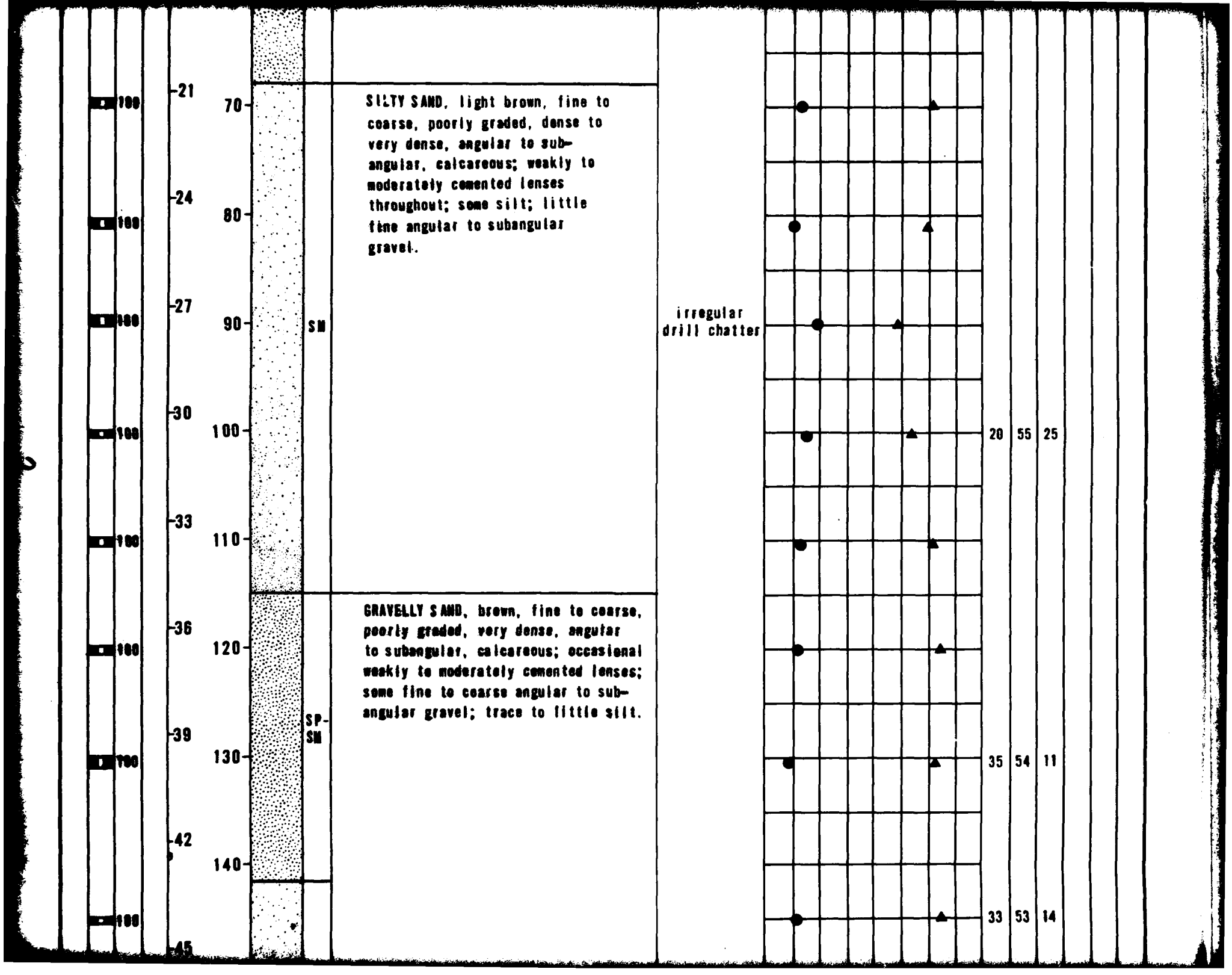
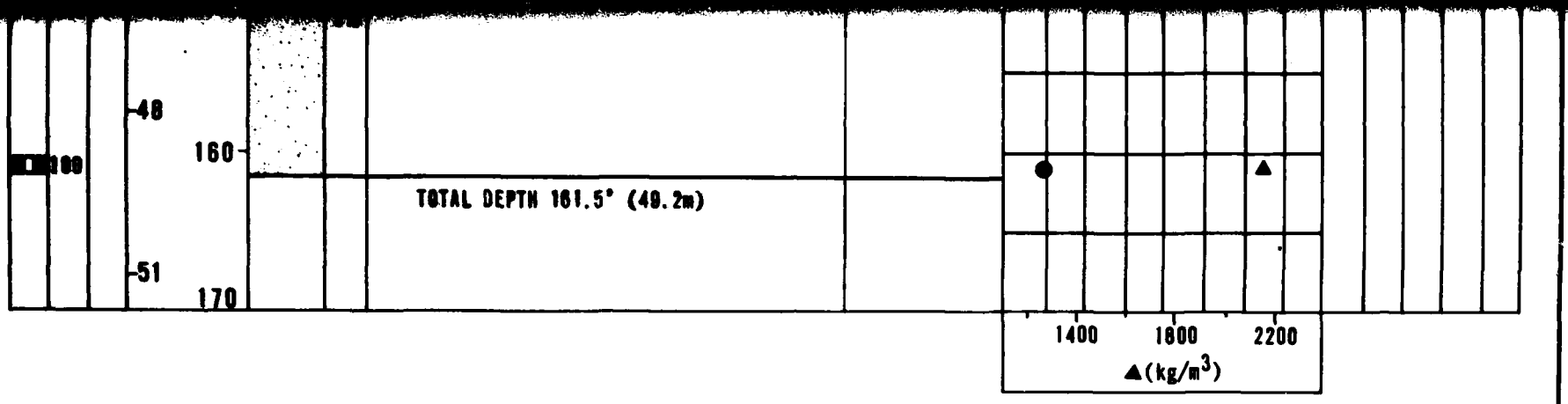
10 AUG 76

FN-18-20-11




100
100
100
100
100
100
100
100
21
24
27
30
33
36
39
42
45
70
80
90
100
110
120
130
140
SM
SP-SM
SILTY SAND, light brown, fine to coarse, poorly graded, dense to very dense, angular to subangular, calcareous; weakly to moderately cemented lenses throughout; some silt; little fine angular to subangular gravel.
GRAVELLY SAND, brown, fine to coarse, poorly graded, very dense, angular to subangular, calcareous; occasional weakly to moderately cemented lenses; some fine to coarse angular to subangular gravel; trace to little silt.
irregular drill chatter
20 55 25
35 54 11
33 53 14



EXPLANATION

- FUGRO DRIVE SAMPLE
- BULK SAMPLE
- PITCHER TUBE SAMPLE
- STANDARD PENETRATION TEST SAMPLE
- CORE SAMPLE
- N - STANDARD PENETRATION RESISTANCE
- ▲ - DRY UNIT WEIGHT (ASTM: D-2937-71)
- ● - MOISTURE CONTENT (ASTM: D-2216-71)
- NR - NO RECOVERY

BORING DETAILS

ELEVATION	: 1560' (475m)
SURFICIAL GEOLOGIC UNIT	: A5i
DATE DRILLED	: 12 & 13 March 1979
DRILLING METHOD	: Rotary Wash
HOLE DIAMETER	: 4 7/8" (124mm)
WATER LEVEL	: Not Encountered

FUGRO NATIONAL, INC.

LOG OF BORING MW-B-5
VERIFICATION SITE, BUTLER COP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE
B-5

AFV-00

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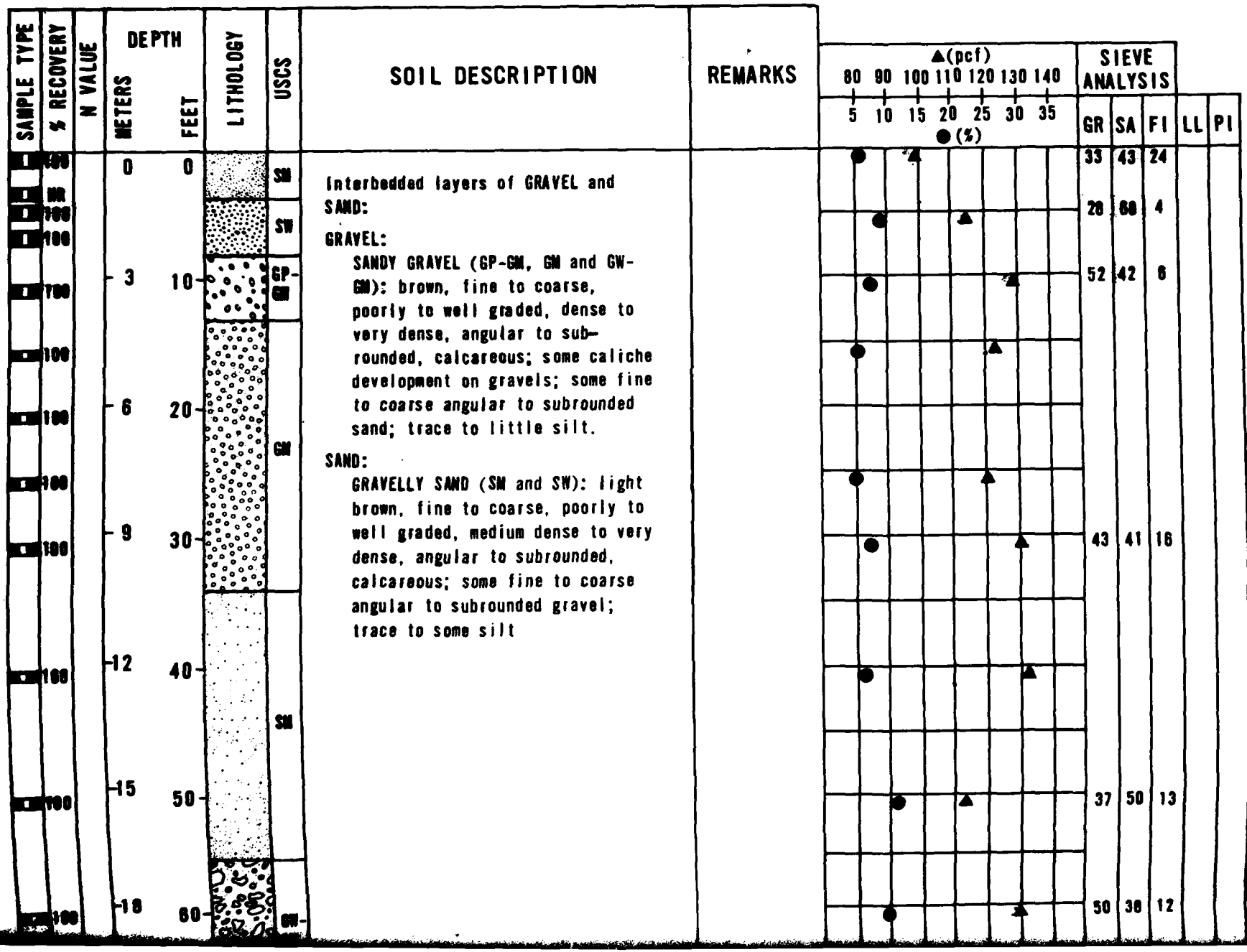
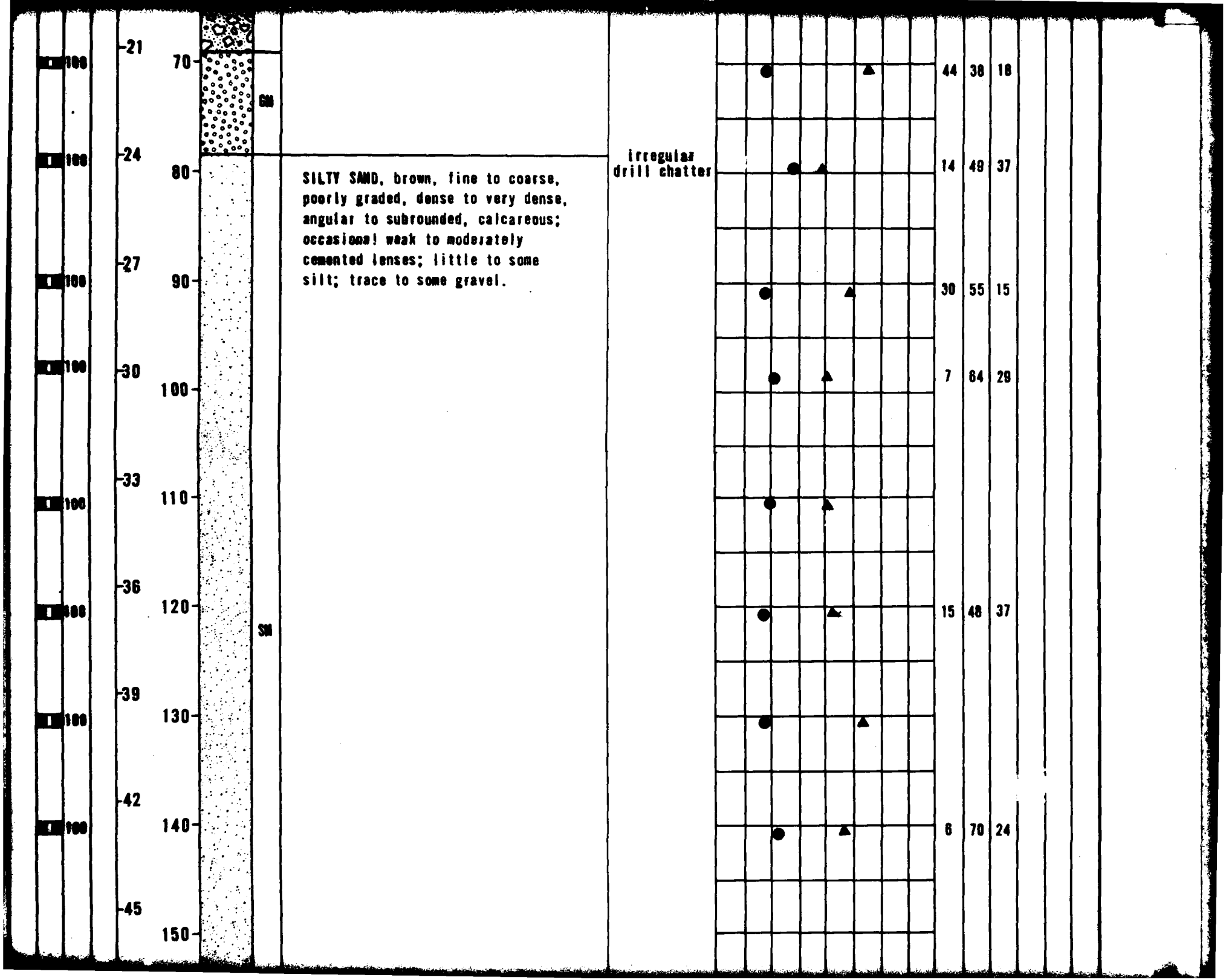
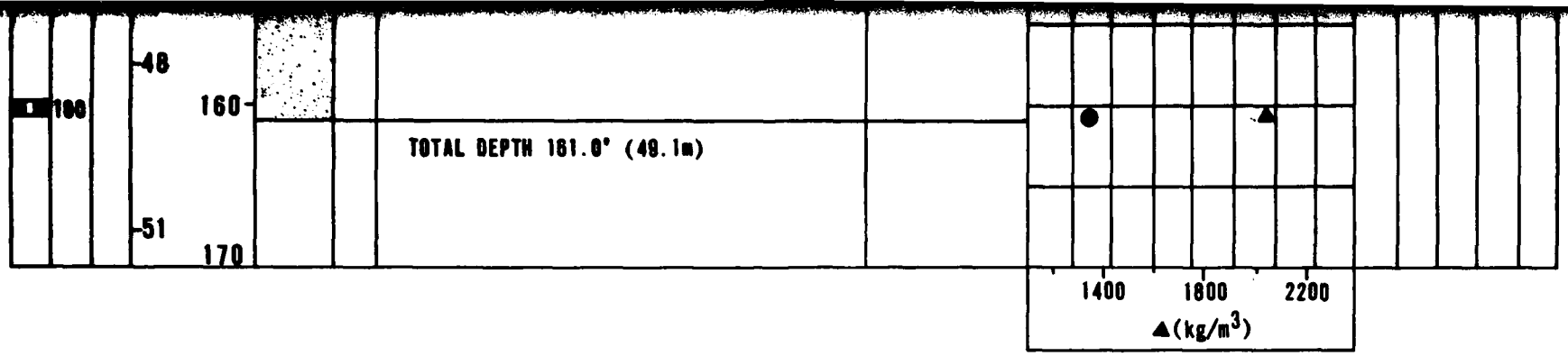



-21
70
GM
-24
80
SILTY SAND, brown, fine to coarse, poorly graded, dense to very dense, angular to subrounded, calcareous; occasional weak to moderately cemented lenses; little to some silt; trace to some gravel.
irregular drill chatter
-27
90
-30
100
-33
110
-36
120
SM
-39
130
-42
140
-45
150
44 38 18
14 49 37
30 55 15
7 64 29
15 48 37
6 70 24



EXPLANATION

- FUGRO DRIVE SAMPLE
- BULK SAMPLE
- PITCHER TUBE SAMPLE
- STANDARD PENETRATION TEST SAMPLE
- CORE SAMPLE
- N – STANDARD PENETRATION RESISTANCE
- ▲ – DRY UNIT WEIGHT (ASTM: D-2937-71)
- ● – MOISTURE CONTENT (ASTM: D-2216-71)
- NR – NO RECOVERY

BORING DETAILS

ELEVATION	: 1120' (341m)
SURFICIAL GEOLOGIC UNIT	: A5i
DATE DRILLED	: 5 & 6 March 1979
DRILLING METHOD	: Rotary Wash
HOLE DIAMETER	: 4 7/8" (124mm)
WATER LEVEL	: Not Encountered

FUGRO NATIONAL, INC.

LOG OF BORING LP-B-6
VERIFICATION SITE, LA POSA COP., ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE B-6

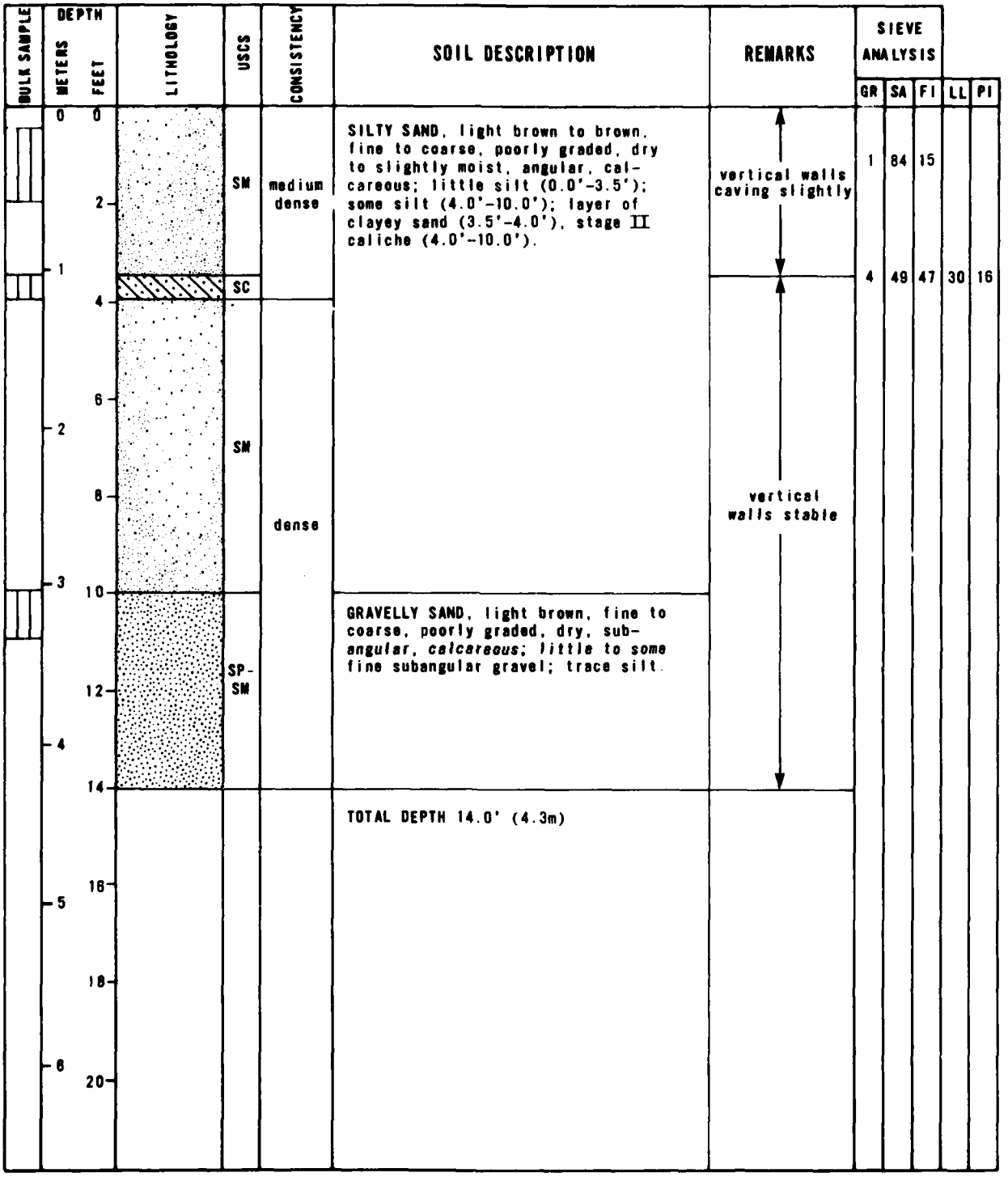
APV-08

SECTION 7.0

TRENCH AND TEST PIT LOGS

EXPLANATION OF TRENCH AND TEST PIT LOGS

See Section 6.0, "Boring Log", for explanations.



TRENCH DETAILS

SURFACE ELEVATION	: 1610' (491m)
DATE EXCAVATED	: 8 MARCH 1979
SURFICIAL GEOLOGIC UNIT	: A5y
TRENCH LENGTH	: 16' (4.9m)
TRENCH ORIENTATION	: NE-SW

LOG OF TRENCH BU-T-1
VERIFICATION SITE, BUTLER COP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE 7-1

WOODWARD-CLYDE CONSULTANTS

FN-TR-28-11

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI	LL	PI
	0	0				GRAVELLY SAND, brown, fine to coarse, poorly graded, dry, angular to subangular, calcareous; fine to coarse, some subangular to subrounded gravel; trace to little silt; occasional cobbles to 11" size; stage I caliche (3.0'-6.0').	vertical walls stable	37	46	17		
		2		SM								
	1	4										
		6			dense							
	2											
		8		SP-SM								
	3	10										
		12										
	4											
		14				TOTAL DEPTH 14.0' (4.3m)						
	5	16										
		18										
	6											
		20										

TRENCH DETAILS

SURFACE ELEVATION : 1930' (588m)
DATE EXCAVATED : 8 MARCH 1979
SURFICIAL GEOLOGIC UNIT : A5y
TRENCH LENGTH : 16' (4.9m)
TRENCH ORIENTATION : E-W

LOG OF TRENCH BU-T-2
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE 7-2

WOODWARD-CLYDE CONSULTANTS

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AFV-04

FN-TR-28-11

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI	LL	PI
	0	0				SAND, light brown, fine to coarse, poorly graded, slightly moist, sub-angular, calcareous; trace silt	vertical walls caving	1	91	8		
		2		SP-SM	medium dense							
	1	4										
		6										
	2					GRAVELLY SAND, red brown, fine to coarse, well graded, dry, sub-angular, calcareous; some fine to coarse subangular gravel; trace silt; stage I caliche (9.0'-14.0')	vertical walls stable	41	52	7		NP
		8										
	3	10		SW-SM	dense							
		12										
	4											
		14				TOTAL DEPTH 14.0' (4.3m)						
		16										
	5											
		18										
	6											
		20										

TRENCH DETAILS

SURFACE ELEVATION : 1425' (434m)
DATE EXCAVATED : 12 MARCH 1979
SURFICIAL GEOLOGIC UNIT : A5y/A1
TRENCH LENGTH : 18' (4 9m)
TRENCH ORIENTATION : N-S

LOG OF TRENCH BU-T-3
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE 7-3

WOODWARD-CLYDE CONSULTANTS

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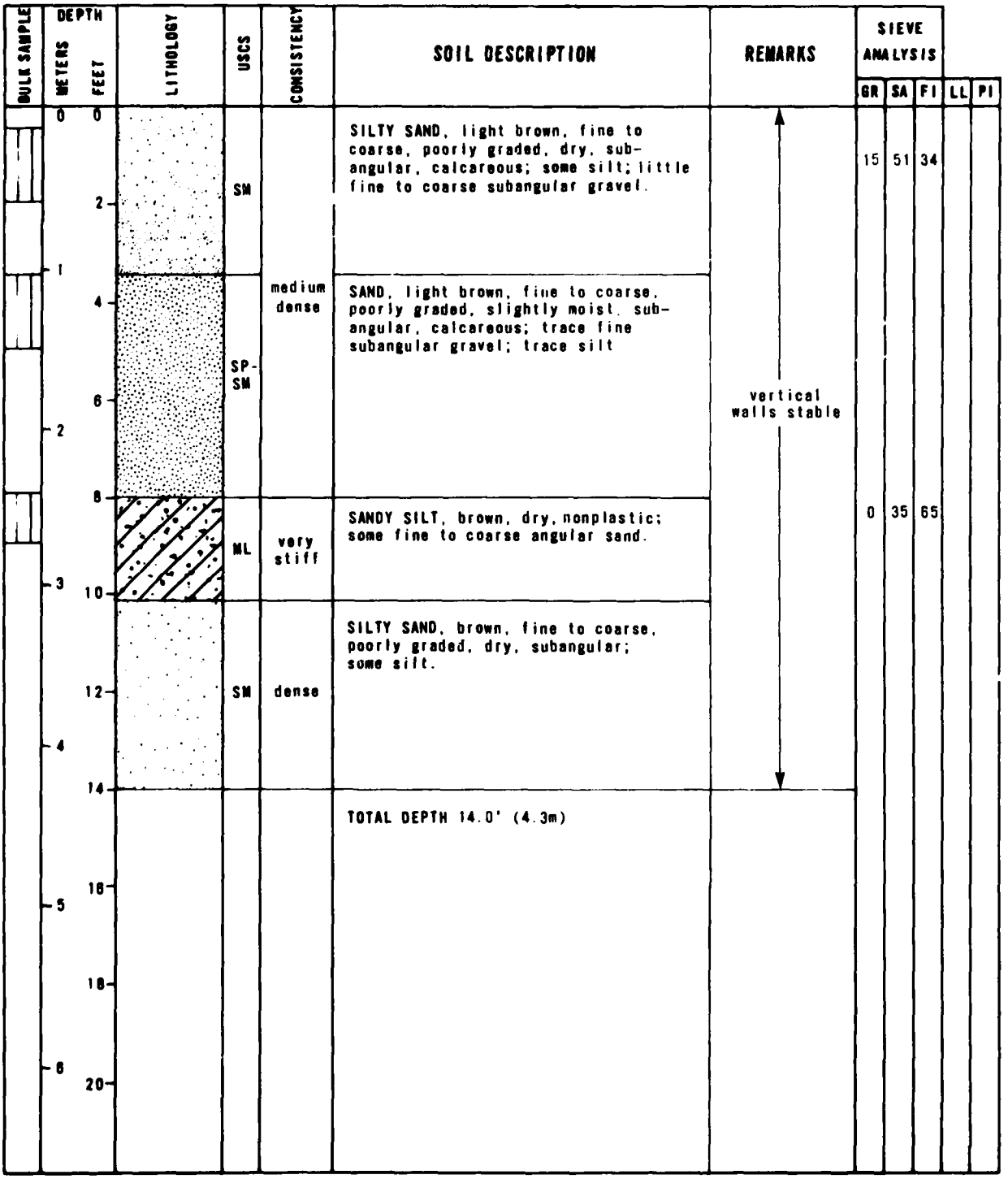
AFV-04



TRENCH DETAILS

SURFACE ELEVATION	: 1350' (411m)
DATE EXCAVATED	: 12 MARCH 1979
SURFICIAL GEOLOGIC UNIT	: A5i
TRENCH LENGTH	: 18' (4.9m)
TRENCH ORIENTATION	: E-W

LOG OF TRENCH BU-T-4
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE 7-4

WOODWARD-CLYDE CONSULTANTS

FN-TR-28-11

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI	LL	PI
	0	0										
		2		SM	medium dense	SILTY SAND, light brown, fine to coarse, poorly graded, dry, subangular, calcareous; little to some silt; trace fine subangular gravel;	vertical walls stable	4	69	27		
	1	4						9	78	13		
		6		SP-SM	medium dense	SAND, light brown, fine to coarse, poorly graded, dry, subangular, calcareous; trace fine subangular gravel; trace silt; stage II caliche (6.5'-10.0').						
	2	8										
	3	10				TOTAL DEPTH 10.0' (3.0m)						
		12										
	4	14										
	5	16										
		18										
	6	20										

TRENCH DETAILS

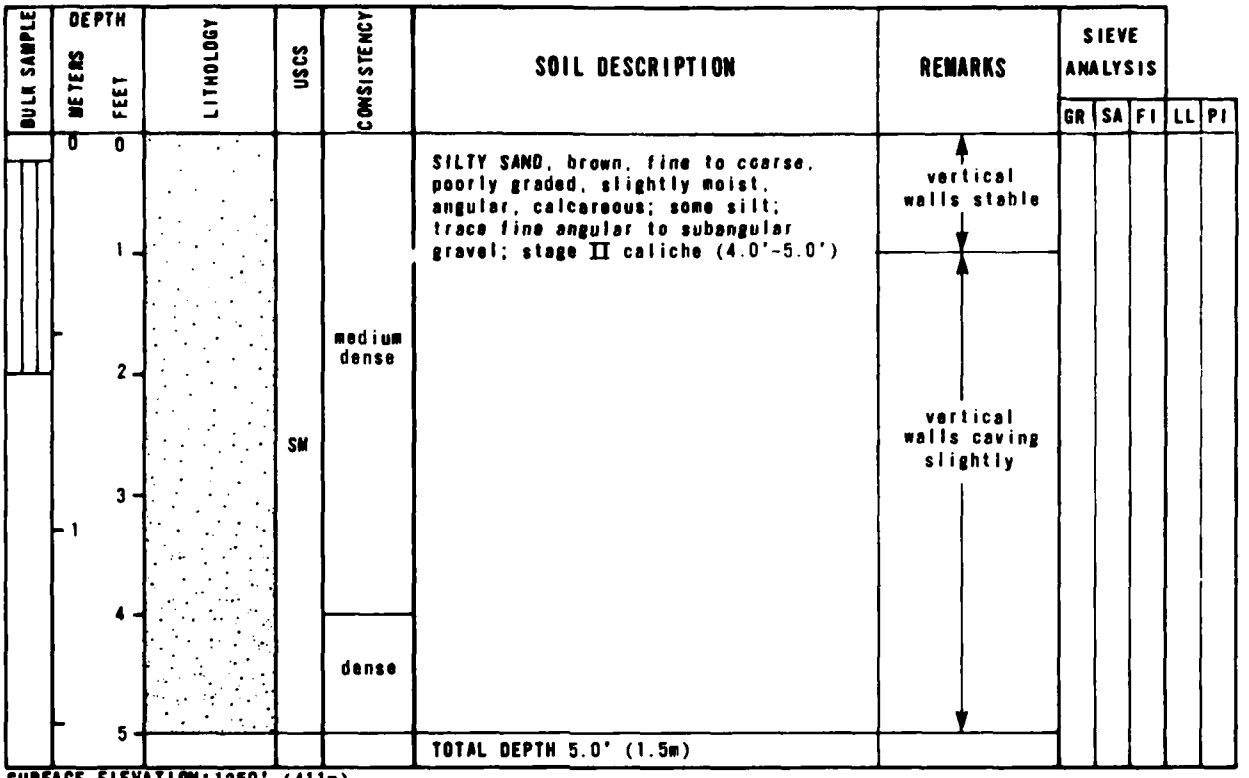
SURFACE ELEVATION : 1925' (587m)
DATE EXCAVATED : 13 MARCH 1979
SURFICIAL GEOLOGIC UNIT : A5y
TRENCH LENGTH : 16' (4.9m)
TRENCH ORIENTATION : NW-SE

LOG OF TRENCH BU-T-5
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE · SAMSO

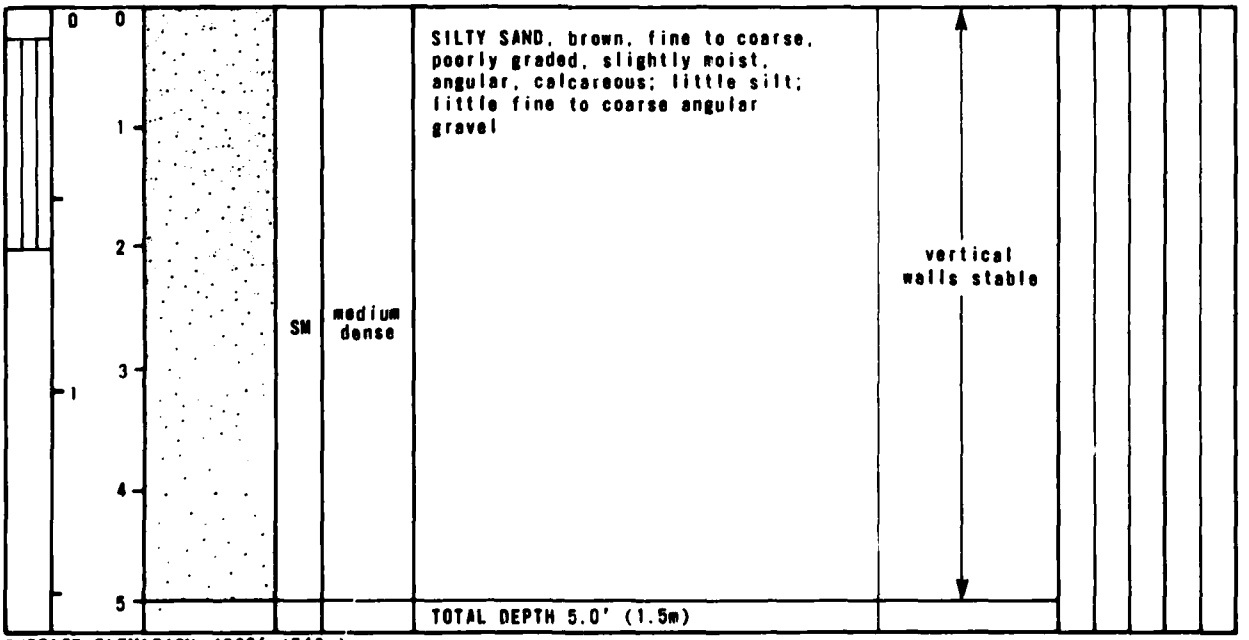
FIGURE 7-5

WOODWARD-NATIONAL, INC.



SURFACE ELEVATION: 1350' (411m)
SURFICIAL GEOLOGIC UNIT: A5y

LOG OF TEST PIT BU-P-1



SURFACE ELEVATION: 1680' (512m)
SURFICIAL GEOLOGIC UNIT: A5i

LOG OF TEST PIT BU-P-2

LOGS OF TEST PITS BU-P-1 AND BU-P-2
VERIFICATION SITE, BUTLER CDP, ARIZONA

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DEPARTMENT OF THE AIR FORCE · SAMSO

FIGURE 7-6

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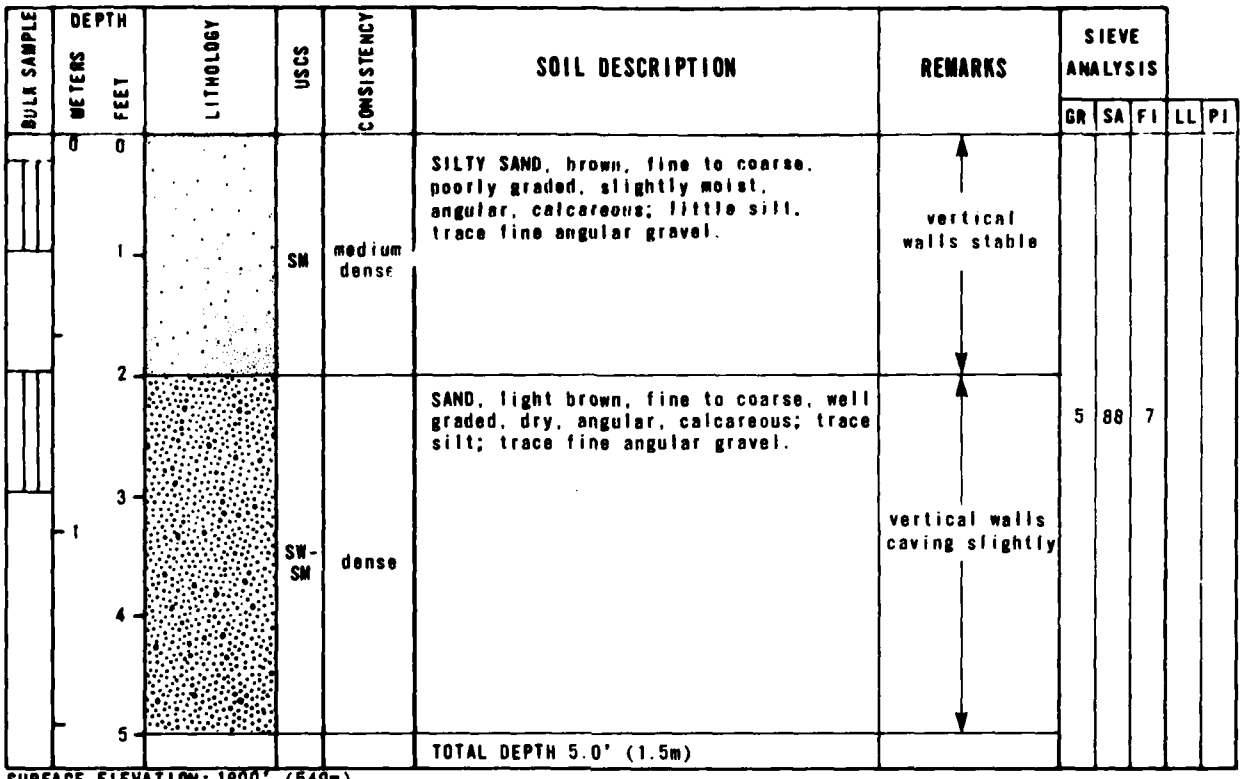


BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI	LL	PI
	0	0		SM	medium dense	SILTY SAND, brown, fine to coarse, poorly graded, slightly moist, angular, calcareous; little silt, trace fine angular gravel.	vertical walls stable					
	1	2		SW-SM	dense	SAND, light brown, fine to coarse, well graded, dry, angular, calcareous; trace silt; trace fine angular gravel.	vertical walls caving slightly	5	88	7		
		5				TOTAL DEPTH 5.0' (1.5m)						

SURFACE ELEVATION: 1800' (549m)
SURFICIAL GEOLOGIC UNIT: A5y

LOG OF TEST PIT BU-P-3

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI	LL	PI
	0	0		CL	firm	SANDY CLAY, brown, slightly moist, slightly plastic, calcareous; some fine to medium subangular sand.	vertical walls stable	2	47	51	26	11
	1	2		SM	medium dense	SILTY SAND, brown, fine to coarse, poorly graded, slightly moist, angular, calcareous; some silt; trace fine subangular gravel.						
		4		SP-SM	dense	SAND, light brown, fine, poorly graded, dry, angular, calcareous; trace silt.						
		5				TOTAL DEPTH 5.0' (1.5m)						

SURFACE ELEVATION: 1455' (443m)
SURFICIAL GEOLOGIC UNIT: A5y

LOG OF TEST PIT BU-P-4

LOGS OF TEST PITS BU-P-3 AND BU-P-4
VERIFICATION SITE, BUTLER COP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

FIGURE 7-7

FUGRO NATIONAL, INC.

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI	LL	PI
	0	0		SM	medium dense	SILTY SAND, brown, fine to coarse, poorly graded, slightly moist, angular, calcareous; some silt; stage III caliche (2.8'-4 5').	vertical walls stable					
		1										
		2										
	1	3			dense							
		4										
		5				TOTAL DEPTH 5.0' (1.5m)						

SURFACE ELEVATION: 1510' (460m)
SURFICIAL GEOLOGIC UNIT: A5y/A3d

LOG OF TEST PIT BU-P-5

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI	LL	PI
	0	0		SC	medium dense	GRAVELLY SAND, light brown, fine to coarse, poorly graded, slightly moist, angular, calcareous; some fine to coarse subangular gravel; some silty clay; stage I caliche (1.0'-2 5')	vertical walls stable	32	47	21		
		1										
		2										
	1	3		SM		SILTY SAND, light brown, fine to coarse, poorly graded, dry, subangular, calcareous; some silt; trace fine subangular gravel; disseminated caliche (2.5'-5.0')						
		4										
		5				TOTAL DEPTH 5.0' (1.5m)						

SURFACE ELEVATION: 1560' (475m)
SURFICIAL GEOLOGIC UNIT: A5i

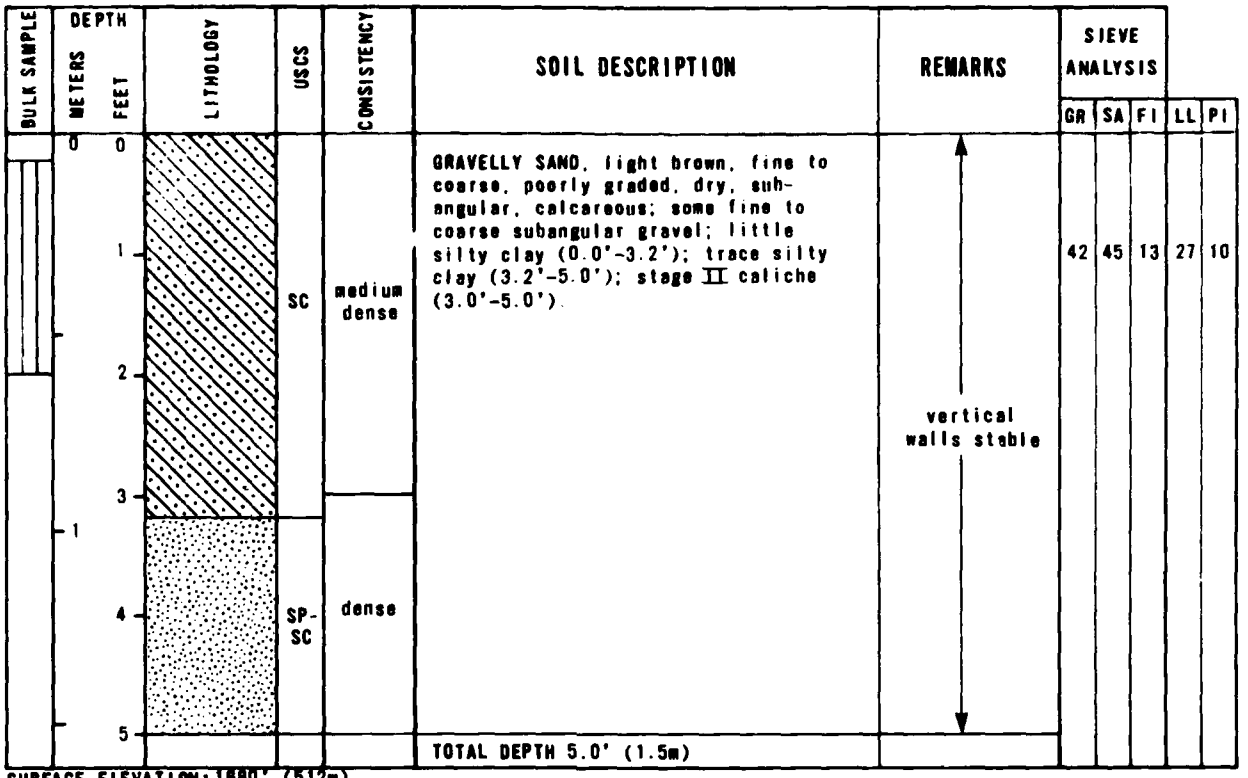
LOG OF TEST PIT BU-P-6

LOGS OF TEST PITS BU-P-5 AND BU-P-6
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE · SAMSO

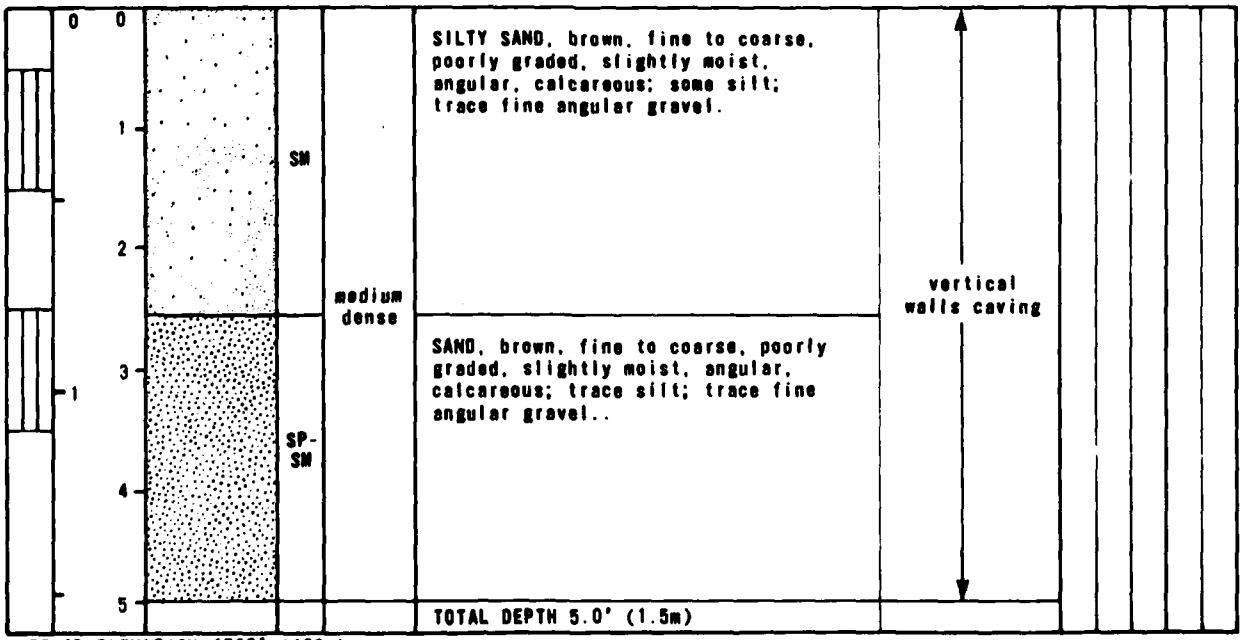
FIGURE 7-8

FN-TR-28-11



SURFACE ELEVATION: 1680' (512m)
SURFICIAL GEOLOGIC UNIT: A5i

LOG OF TEST PIT BU-P-7



SURFACE ELEVATION: 1580' (482m)
SURFICIAL GEOLOGIC UNIT: A5y

LOG OF TEST PIT BU-P-8

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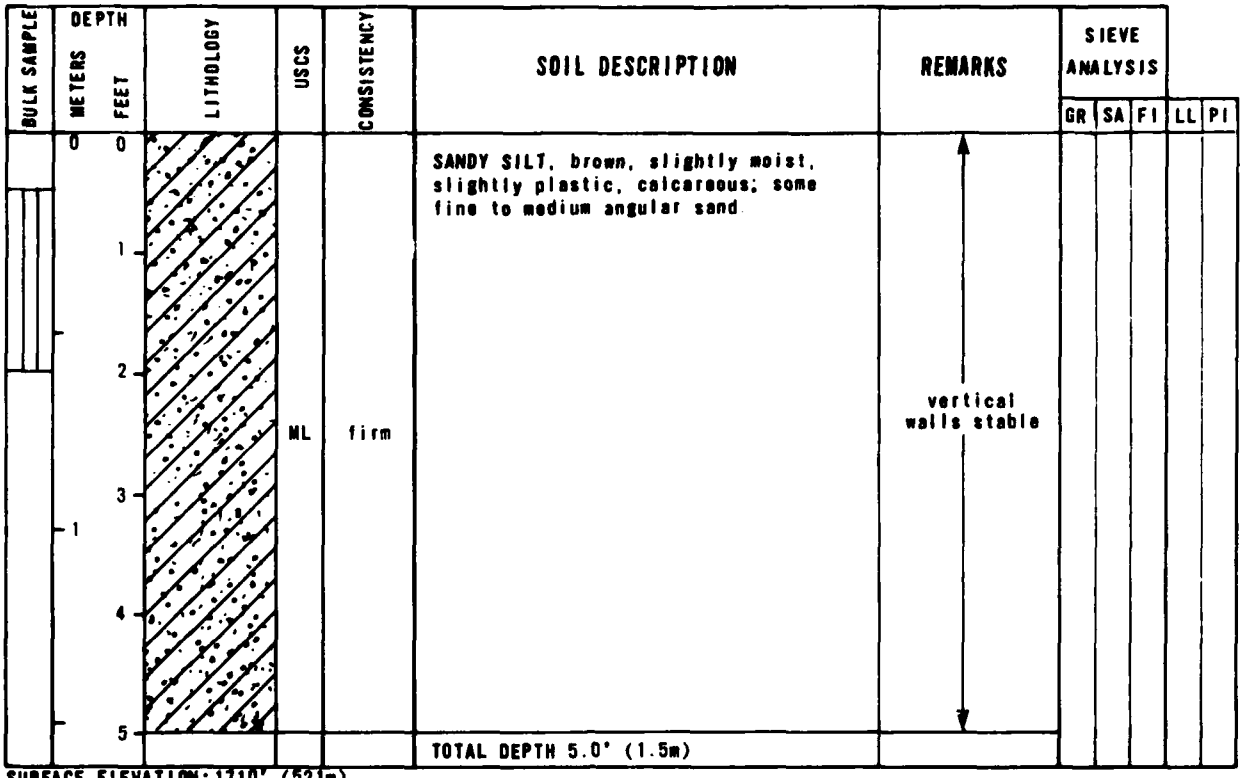
LOGS OF TEST PITS BU-P-7 AND BU-P-8
VERIFICATION SITE, BUTLER CDP, ARIZONA

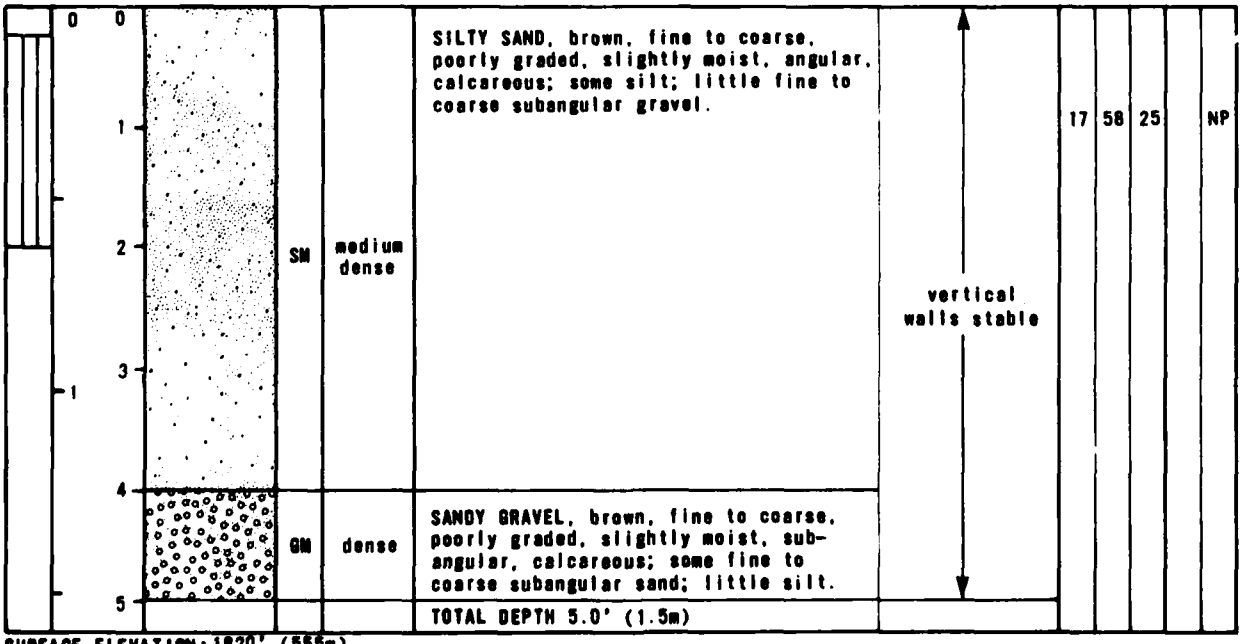
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

FIGURE 7-9



SURFACE ELEVATION: 1710' (521m)
SURFICIAL GEOLOGIC UNIT: A5y

LOG OF TEST PIT BU-P-9



SURFACE ELEVATION: 1820' (555m)
SURFICIAL GEOLOGIC UNIT: A5y

LOG OF TEST PIT BU-P-10

APPROVED BY

CHECKED BY

LOGS OF TEST PITS BU-P-9 AND BU-P-10
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

FIGURE 7-10

FUGRO NATIONAL, INC.

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI	LL	PI
	0	0		SP-SM	medium dense	SAND, brown, fine to coarse, poorly graded, slightly moist, subangular, calcareous; trace silt; trace fine subangular gravel.	vertical walls stable					
	1	1		CL	stiff	SANDY CLAY, red brown, slightly moist, medium plastic, calcareous; some fine to coarse angular sand; trace of subangular gravel; stage II caliche (2.0'-3.25'), stage III caliche (3.25'-3.5').						
	2	2				TOTAL DEPTH 3.5' (1.1m)	cementation at 3.5' exceeded capacity of Case 580C backhoe					
	3	3										
	4	4										
	5	5										

SURFACE ELEVATION: 2030' (619m)
SURFICIAL GEOLOGIC UNIT: A5i

LOG OF TEST PIT BU-P-11

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI	LL	PI
	0	0		SM	medium dense	SILTY SAND, brown, fine to coarse, poorly graded, slightly moist, angular, calcareous; little silt; trace fine angular gravel.	vertical walls stable					
	1	1										
	2	2										
	3	3		SC		CLAYEY SAND, brown, fine to coarse, poorly graded, slightly moist, angular, calcareous; some silty clay; trace fine angular gravel.						
	4	4										
	5	5				TOTAL DEPTH 5.0' (1.5m)						

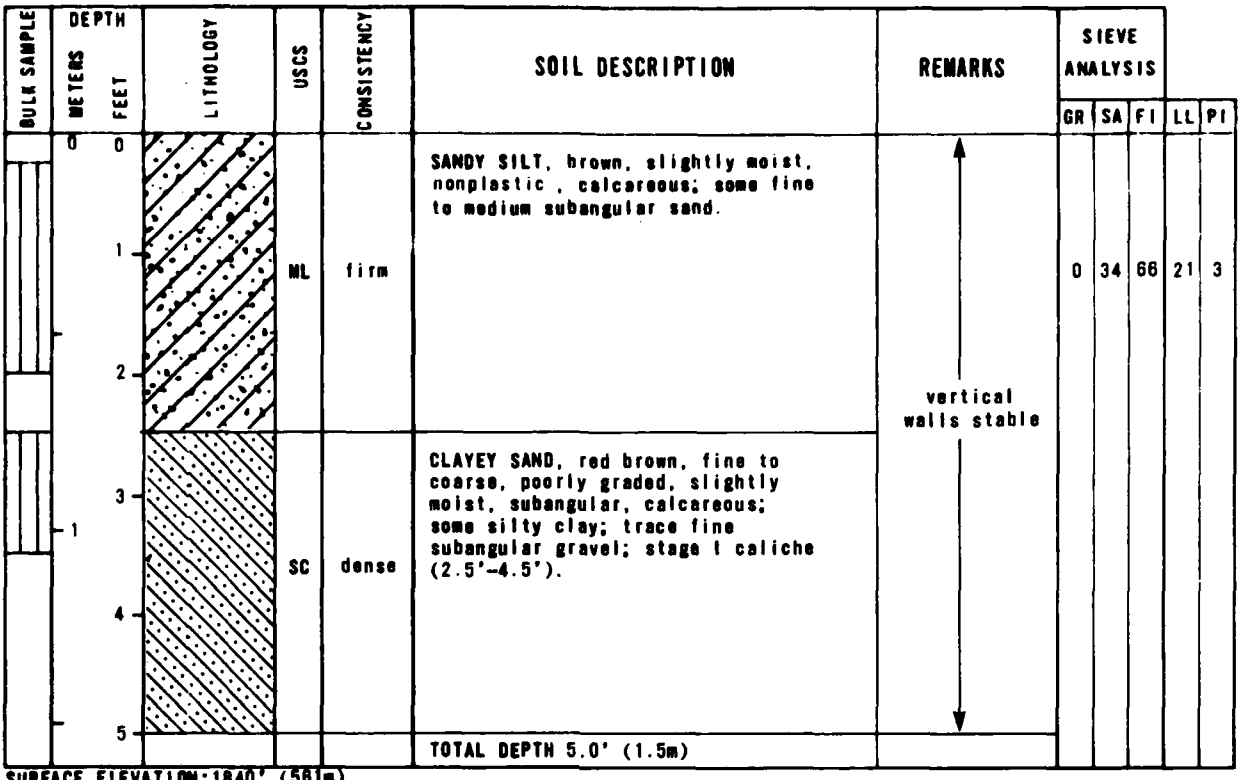
SURFACE ELEVATION: 1930' (588m)
SURFICIAL GEOLOGIC UNIT: A5y

LOG OF TEST PIT BU-P-12

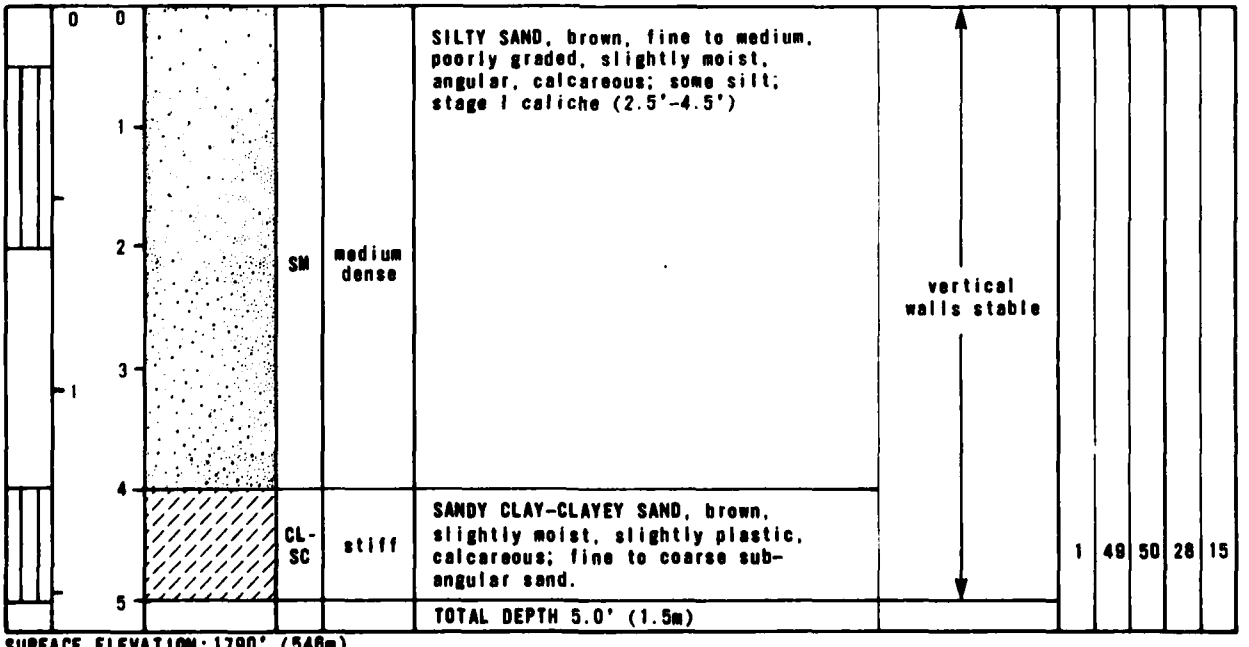
LOGS OF TEST PITS BU-P-11 AND BU-P-12
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE · SAMSO

FIGURE 7-11



LOG OF TEST PIT BU-P-13



LOG OF TEST PIT BU-P-14

LOGS OF TEST PITS BU-P-13 AND BU-P-14
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

FIGURE 7-12

FUGRO NATIONAL, INC.

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI	LL	PI
	0	0				SILTY SAND, brown, fine to coarse, poorly graded, slightly moist, subangular, calcareous; some silt.	vertical walls stable					
		1										
		2		SM	medium dense							
	1	3										
		4										
		5				TOTAL DEPTH 5.0' (1.5m)						

SURFACE ELEVATION: 1770' (539m)
SURFICIAL GEOLOGIC UNIT: A5y

LOG OF TEST PIT BU-P-15

	0	0		GC		SANDY GRAVEL, red brown, fine to coarse, poorly graded, slightly moist, subangular, calcareous; little fine to coarse subangular sand; little silty clay (0.0'-1.5'); little silt (1.5'-5.0'); occasional cobbles to 10" size throughout.	vertical walls stable	47	33	20		
		1										
		2			dense							
	1	3		GM								
		4										
		5				TOTAL DEPTH 5.0' (1.5m)						

SURFACE ELEVATION: 1840' (561m)
SURFICIAL GEOLOGIC UNIT: A5i

LOG OF TEST PIT BU-P-16

LOGS OF TEST PITS BU-P-15 AND BU-P-16
VERIFICATION SITE, BUTLER CDP, ARIZONA

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DEPARTMENT OF THE AIR FORCE SAMSO

FIGURE 7-13

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI	LL	PI
	0	0		SM	medium dense	SILTY SAND, light brown, fine to medium, poorly graded, slightly moist, subangular, calcareous; some silt.	vertical walls stable	2	73	25		
		1										
		2										
	1	3		CL	firm	SANDY CLAY, light brown, slightly moist, slightly plastic, calcareous; some fine to coarse subangular sand; trace fine subrounded gravel.						
		4										
				SP-SM	medium dense	GRAVELLY SAND, light brown, fine to coarse, poorly graded, dry, subangular, calcareous; some fine subangular gravel; trace silt.						
		5				TOTAL DEPTH 5.0' (1.5m)						

SURFACE ELEVATION: 1895' (578m)
SURFICIAL GEOLOGIC UNIT: A5y

LOG OF TEST PIT BU-P-17

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI	LL	PI
	0	0		SM	medium dense	GRAVELLY SAND, light brown, fine to coarse, poorly graded, slightly moist, subangular, calcareous; some fine subangular gravel; little silt.	vertical walls stable	24	58	18		
		1										
		2										
		3		GP-GM	medium dense	SANDY GRAVEL, light brown, fine to coarse, poorly graded, slightly moist, subangular, calcareous; some fine to coarse subangular sand; trace silt.						
	1	4										
		5				TOTAL DEPTH 5.0' (1.5m)						

SURFACE ELEVATION: 2045' (623m)
SURFICIAL GEOLOGIC UNIT: A5i

LOG OF TEST PIT BU-P-18

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CHECKED BY

LOGS OFTTEST PITS BU-P-17 AND BU-P-18
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FIGURE 7-14

FUGRO NATIONAL, INC.

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI	LL	PI
	0	0		CL	firm	SANDY CLAY, light brown, slightly moist, slightly plastic, calcareous; some fine to coarse subangular sand; little subangular gravel; occasional cobbles to 8" size.	vertical walls stable					
		1										
		2										
	1	3		SP-SM	dense	GRAVELLY SAND, light brown, fine to coarse, poorly graded, dry, subangular, calcareous; some fine to coarse subangular gravel; trace silt; occasional cobbles.						
		4				TOTAL DEPTH 4.0' (1.2m)	refusal of Case 580C backhoe at 4.0' on boulders					
		5										

SURFACE ELEVATION: 2170' (661m)
SURFICIAL GEOLOGIC UNIT: A5i

LOG OF TEST PIT BU-P-19

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI	LL	PI
	0	0		GP-GM	medium dense	SANDY GRAVEL, brown, fine to coarse, poorly graded, slightly moist, subangular, calcareous; some fine to coarse subangular sand; trace silt; occasional cobbles to 5" size throughout.	vertical walls stable	45	44	11		
		1										
		2										
	1	3										
		4										
		5				TOTAL DEPTH 5.0' (1.5m)						

SURFACE ELEVATION: 2280' (695m)
SURFICIAL GEOLOGIC UNIT: A5i

LOG OF TEST PIT BU-P-20

APPROVED BY

CHECKED BY

LOGS OF TEST PITS BU-P-19 AND BU-P-20
VERIFICATION SITE, BUTLER CDP, ARIZONA

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FIGURE 7-15

WOODWARD-CLYDE CONSULTANTS

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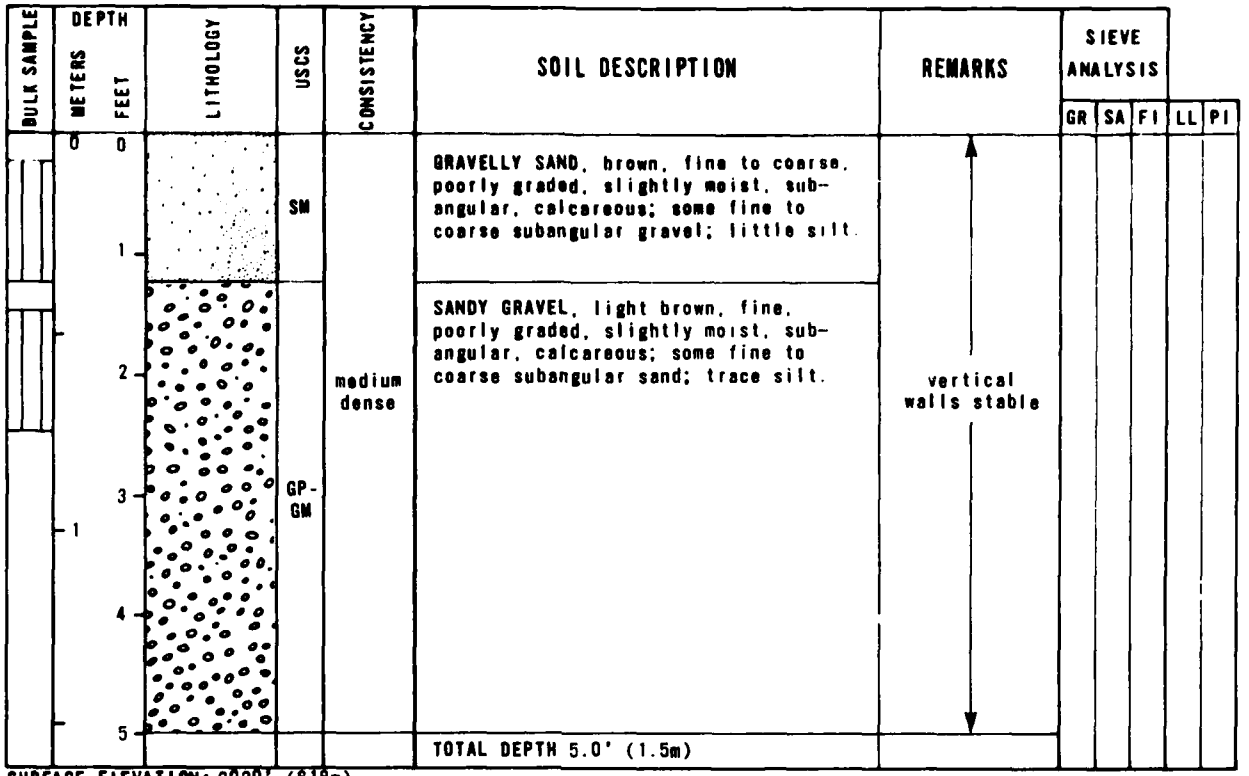
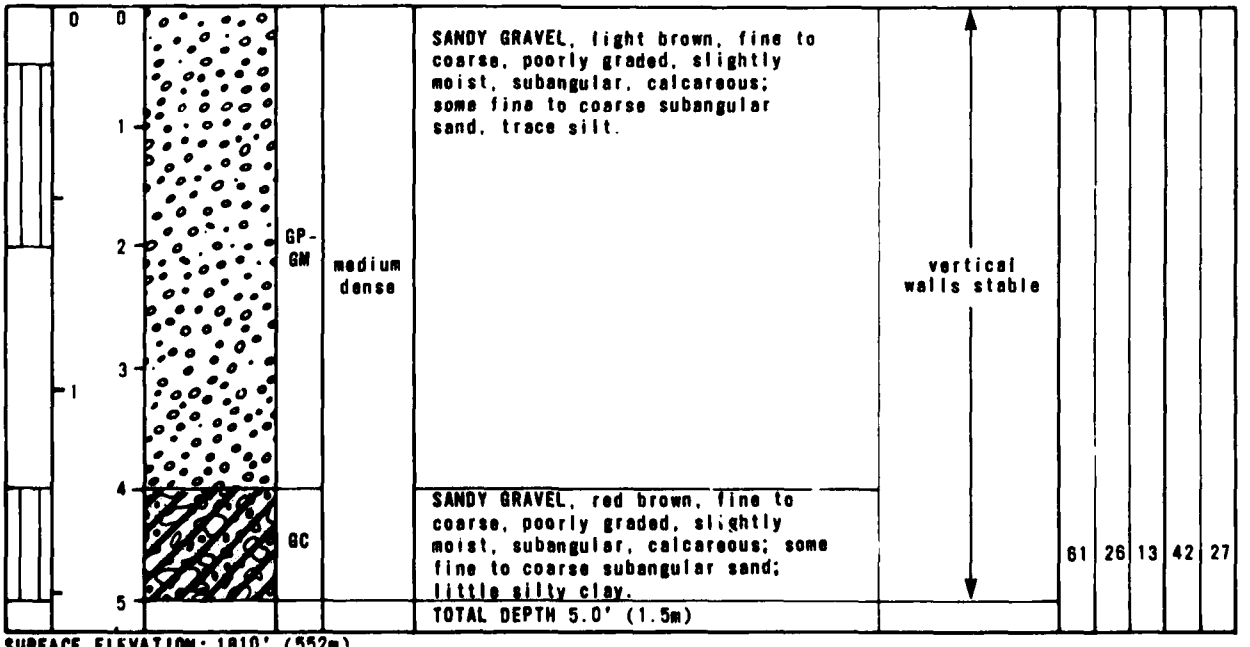


SURFACE ELEVATION: 2020' (616m)
SURFICIAL GEOLOGIC UNIT: A5o

LOG OF TEST PIT BU-P-21



SURFACE ELEVATION: 1810' (552m)
SURFICIAL GEOLOGIC UNIT: A5y/A1

LOG OF TEST PIT BU-P-22

LOGS OF TEST PITS BU-P-21 AND BU-P-22
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DEPARTMENT OF THE AIR FORCE SAMSO

FIGURE 7-16

FN-TR-28-11

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI	LL	PI
	0	0				SILTY SAND, light brown, fine to coarse, poorly graded, slightly moist, subangular, calcareous; some silt.	vertical walls stable					
		1		SM	medium dense							
	1	2										
		3										
		4		SP-SM		SAND, light brown, fine to coarse, poorly graded, dry, subangular, calcareous; trace fine subangular gravel; trace silt.						
		5				TOTAL DEPTH 5.0' (1.5m)						

SURFACE ELEVATION: 1870' (570m)
SURFICIAL GEOLOGIC UNIT: A5y

LOG OF TEST PIT BU-P-23

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI	LL	PI
	0	0				SAND, brown, fine to coarse, poorly graded, slightly moist, subangular, trace silt; trace fine subangular gravel.	vertical walls stable	10	78	12		
		1		SP-SM	medium dense							
	1	2										
		3										
		4										
		5				TOTAL DEPTH 5.0' (1.5m)						

SURFACE ELEVATION: 2030' (619m)
SURFICIAL GEOLOGIC UNIT: A5y

LOG OF TEST PIT BU-P-24

APPROVED BY

CHECKED BY

LOGS OF TEST PITS BU-P-23 AND BU-P-24
VERIFICATION SITE, BUTLER CDP, ARIZONA

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FIGURE 7-17

WOODWARD-CLYDE CONSULTANTS

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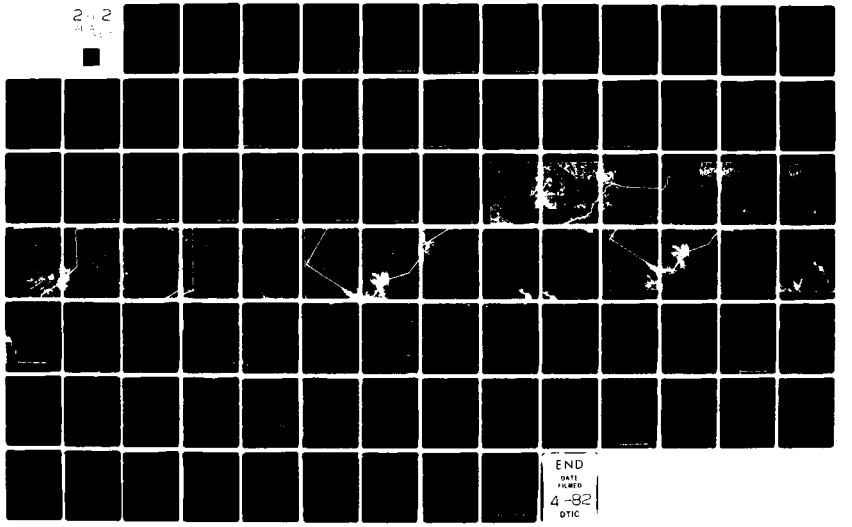
AFV-03

AD-A113 417 FUGRO NATIONAL INC LONG BEACH CA F/G 8/13
MX SITING INVESTIGATION. GEOTECHNICAL EVALUATION. VOLUME II. AR--ETC(U)
NOV 79 F04704-78-C-0027
UNCLASSIFIED FN-TR-28-VOL-2 NL



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4-82
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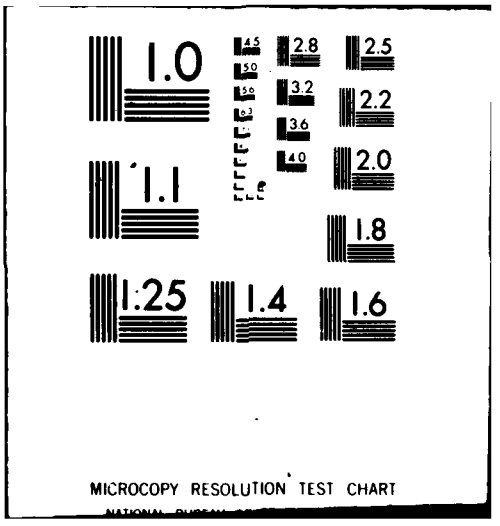
1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3
MICROCOPY RESOLUTION TEST CHART

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI	LL	PI
	0	0				SILTY SAND, light brown, fine to coarse, poorly graded, dry, sub-angular, calcareous; some silt.						
		1										
		2										
		3		SM	medium dense		vertical walls stable					
	1											
		4										
		5				TOTAL DEPTH 5.0' (1.5m)						

SURFACE ELEVATION: 1240' (378m)
SURFICIAL GEOLOGIC UNIT: A5o

LOG OF TEST PIT BU-P-25

	0	0										
		1										
		2										
		3										
	1											
		4										
		5										

SURFACE ELEVATION:
SURFICIAL GEOLOGIC UNIT:

LOG OF TEST PIT

LOG OF TEST PIT BU-P-25
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FIGURE 7-18

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SECTION 8.0

SURFICIAL SAMPLE LOGS

EXPLANATIONS OF SURFICIAL SAMPLE LOGS

Finalized logs of the surficial samples are presented in this section. The explanations provided here are to serve as general guidelines to reading the logs.

A. Designations - Surficial samples are identified as follows:

BU-CS-1

BU - abbreviation for the site (e.g., BU - Butler)
CS - abbreviation for surficial sample
1 - number of activity

B. Ground Surface Elevation - Indicated elevations on the logs are estimated from topographic maps of the study area within an accuracy of half the contour interval.

C. Surficial Geologic Unit - Indicates the surficial geologic unit in which the activity is located.

D. Depth - Indicates depth interval for which soil description is given.

E. USCS - Unified Soil Classification Symbol; see Table 6-1 of Section 6.0, "Boring Logs", for details of USCS.

F. Soil Description - Soil is described based on visual descriptions and/or laboratory test results. See Section 6.0, "Boring Logs", for procedures of soil description.

G. Sieve Analysis, LL and PI - These are from results of laboratory tests. See Section 6.0, "Boring Logs", for explanation.

ACTIVITY NUMBER	GROUND SURFACE ELEVATION, FEET (METERS)	SURFICIAL GEOLOGIC UNIT	DEPTH, FEET (METERS)	USCS	SOIL DESCRIPTION	SIEVE ANALYSIS				
						GR	SA	FI	LL	PI
BU-CS-2	1985 (605)	A5i	0.0-2.0 (0.0-0.61)	SM	SILTY SAND, brown, fine to coarse, poorly graded, medium dense, slightly moist, angular, calcareous; some silt					
BU-CS-4	2040 (622)	A5i	0.0-2.0 (0.0-0.61)	SP-SM	GRAVELLY SAND, brown, fine to coarse, poorly graded, medium dense, slightly moist, angular; some fine to coarse angular gravel; trace silt.					
BU-CS-6	1770 (539)	A5y	0.0-2.0 (0.0-0.61)	SM	SILTY SAND, brown, fine to medium, poorly graded, medium dense, slightly moist, angular, calcareous; some silt.	1	68	31		
BU-CS-8	1650 (503)	A5y	0.0-2.0 (0.0-0.61)	SM	SILTY SAND, brown, fine to coarse, poorly graded, medium dense, slightly moist, angular, calcareous; some silt.					
BU-CS-10	1550 (472)	A5y	0.0-2.0 (0.0-0.61)	SM	SILTY SAND, brown, fine to medium, poorly graded, medium dense, slightly moist, angular, calcareous; some silt.	0	65	35		
BU-CS-12	1530 (466)	A5y	0.0-2.0 (0.0-0.61)	SM	SILTY SAND, brown, fine to medium, poorly graded, dense, slightly moist, angular, calcareous; little silt					
BU-CS-14	1600 (488)	A5y	0.0-2.0 (0.0-0.61)	CL	SANDY CLAY, light brown, firm, dry, medium plastic, calcareous; some fine to coarse angular sand; trace fine angular to subangular gravel; stage I caliche (0.25'-2.0').					
BU-CS-16	1985 (605)	A5y	0.0-2.0 (0.0-0.61)	SM	SILTY SAND, brown, fine to coarse, poorly graded, medium dense, slightly moist, subangular, calcareous; little silt; trace fine subrounded gravel.					
BU-CS-18	2115 (645)	A5i	0.0-2.0 (0.0-0.61)	SM	GRAVELLY SAND, light brown, fine to coarse, poorly graded, medium dense, slightly moist, subangular, calcareous; some fine to coarse subangular gravel; little silt; stage II caliche (1.0'-2.0')					

LOGS OF SURFICIAL SOIL SAMPLES
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
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FIGURE 8-1 1 OF 4

ACTIVITY NUMBER	GROUND SURFACE ELEVATION, FEET (METERS)	SURFICIAL GEOLOGIC UNIT	DEPTH, FEET (METERS)	USCS	SOIL DESCRIPTION	SIEVE ANALYSIS				
						GR	SA	FI	LL	PI
BU-CS-20	2210 (674)	A5i	0.0-1.5 (0.0-0.46)	SM	SILTY SAND, brown, fine to coarse, poorly graded, medium dense, slightly moist, subangular; some silt; trace fine subangular gravel	9	65	26		
			1.5-2.0 (0.46-0.61)	SP-SM	GRAVELLY SAND, light brown, fine to coarse, poorly graded, medium dense, slightly moist, subangular, calcareous; some fine subangular gravel; trace silt					
BU-CS-21	2260 (689)	A5i	0.0-2.0 (0.0-0.61)	SM	GRAVELLY SAND, brown, fine to coarse, poorly graded, medium dense, slightly moist, subangular, calcareous; some fine subangular gravel; little silt.					
BU-CS-24	1950 (594)	A5y/A1	0.0-2.0 (0.0-0.61)	SW-SM	GRAVELLY SAND, light brown, fine to coarse, well graded, medium dense, slightly moist, angular, calcareous; some fine to coarse angular gravel; trace silt.	43	52	5		
BU-CS-25	1910 (582)	A5y	0.0-2.0 (0.0-0.61)	GP-GM	SANDY GRAVEL, light brown, fine to coarse, poorly graded, medium dense, slightly moist, subangular, calcareous; some fine to coarse subangular sand; trace silt.					
BU-CS-27	1500 (457)	A5o	0.0-2.0 (0.0-0.61)	GM	SANDY GRAVEL, light brown, fine, poorly graded, medium dense, dry, subangular, calcareous; some fine to coarse subangular sand; little silt					
BU-CS-28	1425 (434)	A5i	0.0-2.0 (0.0-0.61)	SC	CLAYEY SAND, light brown, fine to coarse, poorly graded, medium dense, dry, subangular, calcareous; some slightly plastic silty clay.	3	54	43	34	11
BU-CS-30	1360 (415)	A5i	0.0-2.0 (0.0-0.61)	SM	GRAVELLY SAND, light brown, fine to coarse, poorly graded, medium dense, dry, subangular, calcareous; some fine to coarse subangular gravel; little silt; stage I caliche throughout.	38	44	18		
BU-CS-37	1810 (552)	A5y	0.0-2.0 (0.0-0.61)	SM	SILTY SAND, brown, fine to medium, poorly graded, medium dense, slightly moist, subangular, calcareous; some silt.	1	68	31		

LOGS OF SURFICIAL SOIL SAMPLES
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
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FIGURE 8-1 2 OF 4

ACTIVITY NUMBER	GROUND SURFACE ELEVATION, FEET (METERS)	SURFICIAL GEOLOGIC UNIT	DEPTH, FEET (METERS)	USCS	SOIL DESCRIPTION	SIEVE ANALYSIS				
						GR	SA	FI	LL	PI
BU-CS-40	1870 (600)	A5y	0.0-2.0 (0.0-0.61)	SM	SILTY SAND, brown, fine to coarse poorly graded, medium dense, slightly moist, subangular, some silt					
BU-CS-43	1845 (593)	A5y	0.0-2.0 (0.0-0.61)	SM	SILTY SAND, brown, fine to coarse, poorly graded, medium dense, slightly moist, subangular, calcareous; some silt.	4	66	30		NP
BU-CS-45	1830 (558)	A5y	0.0-2.0 (0.0-0.61)	ML	SANDY SILT, light brown, firm, slightly moist, slightly plastic, calcareous; some fine to coarse angular sand.					
BU-CS-46	1765 (538)	A5y	0.0-2.0 (0.0-0.61)	ML	SANDY SILT, light brown, firm, slightly moist, nonplastic, calcareous; some fine to coarse subangular sand.					
BU-CS-49	1770 (539)	A5y	0.0-2.0 (0.0-0.61)	SM	SILTY SAND, brown, fine to coarse, poorly graded, medium dense, slightly moist, subangular, calcareous; some silt.					
BU-CS-51	1810 (552)	A5y	0.0-2.0 (0.0-0.61)	SM	SILTY SAND, brown, fine to coarse, poorly graded, medium dense, slightly moist, subangular, calcareous; some silt					
BU-CS-52	1820 (555)	A5y	0.0-2.0 (0.0-0.61)	SM	SILTY SAND, brown, fine to coarse, poorly graded, medium dense, slightly moist, subangular, calcareous; some silt.					
BU-CS-54	1880 (573)	A5y	0.0-2.0 (0.0-0.61)	SM	SILTY SAND; brown, fine to coarse, poorly graded, medium dense, slightly moist, angular, calcareous; some silt					
BU-CS-56	1510 (460)	A5y	0.0-2.0 (0.0-0.61)	CL	SANDY CLAY, brown, firm, slightly moist, slightly plastic, calcareous; some fine to medium angular sand	0	49	51	25	12
BU-CS-57	1470 (448)	A5y	0.0-2.0 (0.0-0.61)	SM	SILTY SAND, brown, fine to coarse, poorly graded, medium dense, slightly moist, angular, calcareous; some silt.					

LOGS OF SURFICIAL SOIL SAMPLES
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
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FIGURE 8-1 3 OF 4

ACTIVITY NUMBER	GROUND SURFACE ELEVATION, FEET (METERS)	SURFICIAL GEOLOGIC UNIT	DEPTH, FEET (METERS)	USCS	SOIL DESCRIPTION	SIEVE ANALYSIS				
						GR	SA	FI	LL	PI
BU-CS-59	1470 (448)	A5y	0.0-2 0 (0 0-0 61)	SC	CLAYEY SAND, brown, fine to medium, poorly graded, medium dense, slightly moist, angular, calcareous; some silty clay.	4	62	34		
BU-CS-61	1740 (530)	A5i	0 0-2.0 (0.0-0.61)	SM	GRAVELLY SAND, light brown, fine to coarse poorly graded, medium dense, slightly moist, angular, calcareous; some fine to coarse angular gravel; little silt; occasional cobbles to 5" size; stage I caliche (1.0'-2.0').	34	50	16		
BU-CS-63	1940 (591)	A5i	0.0-2.0 (0.0-0.61)	SM	SILTY SAND, light brown, fine to coarse, poorly graded, medium dense, dry, angular, calcareous; some silt; stage I caliche (0.25'-2.0').					
BU-CS-64	1360 (415)	A5y	0.0-2.0 (0 0-0.61)	SM	SILTY SAND, brown, fine to coarse , poorly graded, medium dense, slightly moist, angular, calcareous; little silt.	2	82	16		
BU-CS-66	1350 (411)	A5y	0.0-2.0 (0.0-0.61)	SM	SILTY SAND, brown, fine to coarse, poorly graded, medium dense, slightly moist, angular to sub-angular, calcareous; little silt; trace fine angular gravel.	5	77	16		

LOGS OF SURFICIAL SOIL SAMPLES
VERIFICATION SITE, BUTLER COP, ARIZONA

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FIGURE 8-1 4 OF 4

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SECTION 9.0

LABORATORY TEST RESULTS

EXPLANATIONS OF LABORATORY TEST RESULTS

Laboratory test results are presented in this section. Table 9-1 contains a summary of laboratory test results. This table contains results of sieve analysis; plasticity data; in-situ dry unit weight, moisture content, degree of saturation, and void ratio for drive and Pitcher samples; results of compaction tests; and specific gravity of solids. Other tests such as triaxial compression, unconfined compression, direct shear, consolidation, chemical, and California Bearing Ratio (CBR) are indicated on the table. Tables 9-2 through 9-6 and Figures 9-1 through 9-2 present results of triaxial compression, unconfined compression, direct shear, chemical, and CBR tests.

All tests were performed in general accordance with the American Society for Testing and Materials (ASTM) procedures. The following table presents the ASTM designations for the tests performed during the investigation.

Type of Test	ASTM Designations
Particle Size Analysis	D 422-63
Liquid Limit	D 423-66
Plastic Limit	D 424-59
Unit Weight	D 2937-71
Moisture Content	D 2216-71
Compaction	D 1557-70
Specific Gravity of Solids	D 854-58
Triaxial	D 2850-70
Unconfined Compression	D 2166-66
Direct Shear	D 3080-72
Consolidation	D 2435-70
Test for Alkalinity (pH)	D 1067-70
Water Soluble Sodium	D 1428-64
Water Soluble Chloride	D 512-67
Water Soluble Sulphate	D 516-68
Water Soluble Calcium	D 511-72
Calcium Carbonate	D 1126-67
California Bearing Ratio (CBR)	D 1883-73

Explanation for the tables and figures presented in this section are as follows.

A. Activity Number - Boring, trench, test pit, or surficial sample designation.

B. Sample Number - Prefix indicates the type of sample; explanation is at the bottom of the table.

C. Sample Interval - This is the depth range measured from ground surface over which the sample was obtained.

D. Percent Finer by Weight - Presents the results of laboratory particle size analysis (ASTM D 422-63) performed on representative soil samples at the depth indicated. The numbers represent the percent (by dry weight) of the total sample weight passing through each sieve size indicated.

E. Atterberg Limits (ASTM D 423-66 and D 424-59)

LL - Liquid Limit, the water content (as percent of soil dry weight) corresponding to the arbitrary limit between the liquid and plastic states of consistency of a soil (ASTM D 423-66).

PL - Plastic Limit, the water content corresponding to an arbitrary limit between the plastic and the semisolid state of consistency of a soil (ASTM D 424-59).

PI - Plasticity Index, numerical difference between the liquid limit (LL) and the plastic limit (PL) indicating the range of moisture content within which a soil-water mixture is plastic.

NP - Nonplastic.

F. USCS - Unified Soil Classification Symbols are given here; see Table 6.1 in Section 6.0, "Boring Logs", for complete details of USCS system.

G. In Situ - Presents results of tests on drive and Pitcher samples.

Dry Unit Weight - indicates dry unit weight of soil determined as per ASTM D 2937-71

Moisture Content - weight of water reported in percent of dry weight of soil sample (ASTM D 2216-71)

Saturation - the degree of saturation in a soil sample is defined as the ratio (in percent) of the volume of water to the volume of all voids in the soil

Void Ratio - the numerical ratio of the volume of voids to the volume of solids in a soil specimen

H. Compacted - Indicates results of laboratory maximum dry density and optimum moisture content test as per ASTM D 1557-70.

I. Specific Gravity of Solids (ASTM D 854-58) - Indicates the ratio of (1) the weight in air of a given volume of soil solids at a stated temperature, to (2) the weight in air of an equal volume of distilled water at a stated temperature.

J. Triaxial - The triaxial compression tests were performed in accordance with the procedures of ASTM D 2850-70. The following explanations and definitions apply.

Triaxial Compression Test - a cylindrical specimen of soil is surrounded by a fluid in a pressure chamber and subjected to an isotropic pressure. An additional compressive load is then applied, directed along the axis of the specimen called the axial load.

Consolidated-Drained (CD) Test - a triaxial compression test in which the soil was first consolidated under an all-around confining stress (test chamber pressure), and was then compressed (and hence sheared) by increasing the vertical stress. Drained indicates that excess pore water pressure generated by strains are permitted to dissipate by the free movement of pore water during consolidation and compression.

Consolidated-Undrained (CU) Test - a triaxial compression test in which essentially complete consolidation under the confining (chamber) pressure is followed by a shear test at constant water content.

Confining Pressure (σ_3) - the isotropic chamber pressure applied to the soil specimen during consolidation and compression.

Maximum Deviator Stress ($\sigma_1-\sigma_3$) - the difference between the major and minor principal stresses in the specimen at failure. The major principal stress on the specimen is equal to the unit axial load plus the chamber pressure and the minor principal stress on the specimen is equal to the chamber pressure.

Strain Rate - axial strain, ε, at a given stress level is defined as the ratio of the change in length (ΔL) of the specimen to the original length of the specimen (L_o). The rate of strain was controlled during the test so that this ratio increased at equal increments for each minute of testing.

Back Pressure - pressure in excess of atmospheric applied to the pore water of a soil sample. Back pressure is usually applied to (1) increase saturation of the sample, or (2) simulate the actual in-situ pressure regime.

K. Unconfined Compression - Test procedures were as described in ASTM D 2166-66. Unconfined compressive strength is defined as the load per unit area at which an unconfined prismatic or cylindrical specimen of soil will fail in a simple compression test. In these methods, unconfined compressive strength is taken as the maximum load attained per unit area or the load per unit area at 20 percent axial strain, whichever occurred first during the performance of a test.

L. Direct Shear - The procedures of ASTM D 3080-72 were followed for direct shear testing. In this test, soil under an applied normal load is stressed to failure by moving one section of the soil container (shear box) relative to the

other section. Normal stress is the value of load per unit area acting perpendicular to the plane of shearing. Maximum shear strength is defined as the maximum resistance (ksf) of a soil to shearing (tangential) stresses.

M. Consolidation (ASTM D 2435-70) - A consolidation test is a test in which a cylindrical soil specimen is laterally confined in a ring and compressed between porous plates. The term "consolidation", as used here, indicates the gradual reduction in volume of the soil mass resulting from an increase in compressive stress (axial load per unit area).

N. Chemical - The chemical tests performed on soil samples included: pH; water soluble sodium, chloride, sulphate, calcium; and calcium carbonate content. pH is an index of the acidity or alkalinity of a soil in terms of the logarithm of the reciprocal of the hydrogen ion concentration. ASTM test procedure designations for these chemical tests are included in the table at the beginning of the "Explanation of Laboratory Test Results".

O. CBR - California Bearing Ratio (CBR) is the ratio (in percent) of the resistance to penetration developed by a subgrade soil to that developed by a standard crushed-rock base material. The procedures for conducting a CBR test were as outlined in ASTM D 1883-73. The materials tested for CBR were also analyzed for particle size distribution (ASTM D 422-63) and compaction characteristics (ASTM D 1557-70). The term "percentage of maximum density" indicates the ratio (as a percentage) of the compacted sample

dry unit weight to maximum dry density obtained in the laboratory from ASTM D 1557-70, "Moisture-Density Relations of Soils Using 10-pound (4.5 kg) Hammer and 18-inch (457 mm) Drop."

ACTIVITY NUMBER	SAMPLE NUMBER (a)	SAMPLE INTERVAL		PERCENT FINER BY WEIGHT									
				STANDARD SIEVE OPENING							U S STANDARD SAND		
				BLDRS.	COBBLES		GRAVEL						
		FEET	METERS	24"	12"	6"	3"	1½"	3/4"	3/8"	4	10	40
BU-B-1	P-1	1.0-3.7	0.30-1.13										
	P-2	4.0-6.5	1.22-1.98							100	99	89	21
	D-3	7.0-8.0	2.13-2.44										
	D-4	10.2-10.9	3.11-3.32						100	97	92	81	43
	D-5	15.0-15.7	4.57-4.79										
	D-6	20.2-20.9	6.16-6.37						100	97	94	69	35
	D-7	25.0-26.0	7.62-7.92										
	D-8	30.2-30.7	9.20-9.36						100	97	91	76	34
	D-9	40.0-41.0	12.19-12.50										
	D-10	50.0-51.0	15.24-15.54							100	98	78	17
	D-11	60.0-61.0	18.29-18.59										
	D-12	68.0-69.0	20.73-21.03										
	D-13	80.4-80.9	24.51-24.66							100	96	73	25
	D-14	90.0-91.0	27.43-27.74										
	D-15	100.2-100.9	30.54-30.75							100	94	66	22
	D-16	107.2-107.9	32.67-32.89							100	99	98	77
	D-17	116.0-117.0	35.36-35.66										
	D-18	129.4-129.9	39.44-38.68							100	93	73	26
	D-19	145.0-146.0	44.20-44.50										
	D-20	160.4-160.9	48.89-49.04						100	94	91	77	26
BU-B-2	P-1	0.0-2.7	0.00-0.82										
	P-2	3.5-4.3	1.07-1.31					100	96	90	85	71	21
	D-3	6.0-7.0	1.83-2.13										
	D-4	10.2-10.9	3.11-3.32										
	D-5	15.2-15.9	4.63-4.85						100	99	97	91	60
	D-6	20.0-21.0	6.10-6.40										
	D-7	25.0-25.6	7.62-7.80								100	99	98
	P-8	30.0-31.1	9.14-9.48									100	99
	D-9	37.1-37.7	11.31-11.49						100	92	73	53	22
	D-10	41.2-41.9	12.56-12.77								100	93	74
	P-12	58.0-59.3	17.68-18.07							100	98	89	52
	D-13	71.0-72.0	21.64-21.95										
	D-14	80.0-81.0	24.38-24.69										
	D-15	90.2-90.9	27.49-27.71						100	95	87	56	15
	D-16	98.0-98.8	29.87-30.11										
	P-17	108.5-110.5	33.07-33.68										
	P-18	120.7-121.4	36.79-37.00									100	95
	P-19	130.0-131.7	39.62-40.14										
	P-20	144.0-144.9	43.89-44.17								100	99	93
	P-21	160.0-161.9	48.77-49.35						100	96	94	90	70
BU-B-3	D-1	0.0-1.0	0.00-0.30										

NOTES:

(a) Sample types
- SS - Standard split spoon
- P - Pitcher
- D - Fugro Drive
- B,b - Bulk

(b) NP - Not Plastic

(c) USCS - Unified Soil Classification System

(d) * Indicates that test has been performed and results are included in this report

SIEVE NO.		PARTICLE SIZE (mm)		ATTERBERG LIMITS (b)			USCS (c)	IN-SITU					COMPACTED			SPECIFIC GRAVITY OF SOLIDS	TRIAXIAL (d)	UNCONFINED COMPRESSION	DIRECT
	SILT OR CLAY							DRY UNIT WEIGHT		MOISTURE CONTENT (%)	SATURATION (%)	VOID RATIO	MAXIMUM DRY DENSITY		OPTIMUM MOISTURE (%)				
100	200	.005	.001	LL	PL	PI		(pcf)	(kg/m³)				(pcf)	(kg/m³)					
							SM	107.4	1720	5.4	25.6	0.57							
3	1						SP	107.9	1728	1.2	6.0	0.53				2.64			
							SP	112.1	1796	1.0	5.4	0.50							
33	29			74	28	46	SC	111.2	1781	9.4	49.3	0.52							
							SM	108.4	1736	14.3	69.7	0.55							
20	17						SM	119.1	1908	7.2	46.9	0.41							
							SP-SM	111.4	1784	6.9	36.4	0.51							
17	12						SW-SM	113.1	1812	5.6	30.9	0.49							
							SP-SM	116.2	1861	7.6	45.6	0.45							
7	5						SP-SM												
							SP-SM	109.4	1752	4.5	22.5	0.54							
							SP-SM	118.4	1897	5.2	33.2	0.42							
13	11						SP-SM	118.1	1892	5.2	32.3	0.43							
							SP-SM	113.9	1825	4.2	23.7	0.48							
12	10						SW-SM	119.2	1909	5.6	36.6	0.41							
42	32						SM	114.8	1839	6.7	38.7	0.47							
							SM	113.0	1810	8.7	47.8	0.49							
11	8						SW-SM	121.7	1949	3.2	22.5	0.38							
							SW-SM	122.4	1961	5.1	36.6	0.38							
12	9						SW-SM	120.7	1933	4.4	30.0	0.40							
							SP-SM	80.6	1291	16.8	41.6	1.09							
10	8						SW-SM			1.8									
							SP-SM	115.6	1852	2.5	14.8	0.46							
							SM	109.8	1759	4.5	23.6	0.51				2.65			
37	30						SM	113.5	1818	5.0	27.9	0.48							
							ML	98.4	1576	10.6	40.2	0.71							
92	80						ML	100.0	1602	10.7	42.2	0.68							
94	87						ML	93.0	1490	16.5	54.9	0.81							
8	5						SP-SM	121.1	1940	4.9	33.8	0.39							
54	42						SM	121.5	1946	3.9	27.2	0.39							
37	31						SM	105.9	1696	9.5	43.4	0.59							
							SP	104.0	1666	6.3	27.4	0.62							
							SP	116.4	1865	3.3	19.9	0.45							
7	4						SW	122.9	1969	7.5	54.6	0.37							
							SM	101.2	1621	14.7	59.7	0.66							
							SM	99.7	1597	21.8	85.3	0.69							
65	20						SM	105.9	1696	16.4	74.9	0.59							
							SM	97.6	1563	22.6	84.0	0.73							
84	70			36	23	13	CL	104.3	1671	21.5	94.9	0.61				2.69			

	TRIAXIAL (d)	UNCONFINED COMPRESSION	DIRECT SHEAR	CONSOLIDATION	CHEMICAL	CBR
			*			
			*			
			*			
					*	
			*			
					*	
			*			
					*	
					*	
					*	
					*	

SUMMARY OF LABORATORY TEST RESULTS
VERIFICATION SITE, BUTLER COP, ARIZONA

MX SITING INVESTIGATION
EPARTMENT OF THE AIR FORCE - SAMSO

TABLE
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ERS NATIONAL, INC.

AFV-01

47.5-48.5	14.48-14.78		
60.0-60.5	18.29-18.50		
88.2-88.9	26.88-27.10		
99.0-99.5	30.18-30.33		
110.0-110.5	33.53-33.68		
120.0-120.5	36.58-36.73		
130.0-130.4	39.62-39.75		
144.0-144.3	43.89-43.98		
0.0-2.8	0.00-0.85		
3.7-4.4	1.13-1.34		
6.0-7.0	1.83-2.13		
10.2-10.9	3.11-3.32		
15.2-15.9	4.63-4.85		
19.0-20.0	5.79-6.10		
25.0-25.6	7.62-7.80		
30.0-30.7	9.14-9.36		
40.0-41.0	12.19-12.50		
50.0-50.7	15.24-15.45		
60.1-60.8	18.32-18.53		
70.0-70.8	21.34-21.58		
80.0-80.6	24.38-24.57		
90.2-90.9	27.49-27.71		
100.0-101.0	30.48-30.78		

			SP-SM	109.8	1759	6.2	31.3
			SW-SM	124.6	1996	5.8	44.5
37	19	18	SC	106.7	1709	10.4	48.5
			SP-SM	121.3	1943	3.6	25.0
			SM	107.5	1722	8.6	40.9
			SW-SM	127.2	2038	6.7	55.7
			SP-SM	125.3	2007	6.0	47.0
			SP-SM	123.8	1983	7.3	54.6
			SW-SM	132.7	2126	5.8	58.1
			SW-SM	137.0	2195	4.9	57.6
			SW-SM	136.4	2185	5.3	60.8
			SM				
			SM	104.2	1669	5.5	24.1
			SM	106.7	1709	3.9	18.2
			SM	114.2	1829	5.4	30.7
			SM	109.3	1751	5.2	27.3
			SW-SM	121.2	1941	5.8	41.3
			SM	122.4	1961	5.2	37.3
46	20	26	SC	116.4	1865	7.6	45.9
			SM	117.4	1881	8.8	54.6
			SM	111.2	1781	7.0	36.7
			SM	112.0	1794	7.7	41.2
			SM	110.1	1764	9.8	49.9
			SM	96.8	1550	8.3	30.3
			SM	117.4	1881	13.3	82.5
			SM	120.3	1927	6.6	44.5
			SM	122.2	1957	5.8	41.3
			SM	122.1	1956	8.3	59.0

(%)	SPECIFIC GRAVITY OF SOLIDS	TRIAXIAL (d)	UNCONFINED COMPRESSION	DIRECT SHEAR	CONSOLIDATION	CHEMICAL	CBR
				*			
						*	
	2.63			*			
	2.67			*			
						*	
						*	
						*	
	2.66						

SUMMARY OF LABORATORY TEST RESULTS
VERIFICATION SITE, BUTLER COP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE
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2 OF 4

USBR NATIONAL INC.

AFV-01

AC NU	SA NU	FEET	METERS	24"	12"	6"	3"
BU-B-5	D-7	25.2-25.9	7.68-7.89				
	D-8	29.1-29.6	8.87-9.02				
	D-9	35.0-35.6	10.67-10.85				
	P-10	40.0-41.6	12.19-12.68				
	D-11	50.0-50.7	15.24-15.45				
	D-12	60.0-60.4	18.29-18.41				
	D-13	70.0-70.4	21.34-21.46				
	D-14	81.0-81.6	24.69-24.87				
	D-15	90.0-90.6	27.43-27.62				
	D-16	100.0-100.4	30.48-30.60				
	D-17	110.0-110.4	33.53-33.65				
	D-18	120.0-120.4	36.58-36.70				
	D-19	130.2-130.9	39.68-39.90				
	D-20	145.0-145.4	44.20-44.32				
	D-21	160.5-161.4	48.92-49.19				
BU-T-1	B-1	0.5-2.0	0.15-0.61				
	b-2	3.5-4.0	1.07-1.22				
BU-T-2	B-1	0.5-2.0	0.15-0.61				
BU-T-3	B-1	0.5-2.0	0.15-0.61				
	b-2	7.0-8.0	2.13-2.44				
BU-T-4	B-1	0.5-2.0	0.15-0.61				
	b-3	8.0-9.0	2.44-2.74				
BU-T-5	B-1	0.5-2.0	0.15-0.61				
	b-2	3.0-4.0	0.91-1.22				
BU-P-3	B-2	2.0-3.0	0.61-0.91				

ATTERBERG LIMITS (b)			USCS (c)	DRY UNIT WEIGHT		MOISTURE CONTENT (%)	SATURATION (%)	VOID RATIO	MAXIMUM DRY DENSITY		OPTIMUM MOISTURE (%)	SPECIFIC GRAVITY OF SOLIDS	TRIAXIAL	UNCONFINED
LL	PL	PI		(pcf)	(kg/m^3)				(pcf)	(kg/m^3)				
			SW-SM	122.7	1965	4.0	28.9	0.37						
			SM	106.4	1704	9.9	45.8	0.58						
			SM	102.4	1640	11.3	47.3	0.65						
			SM	109.5	1754	10.4	52.1	0.54						
			SM	126.8	2031	5.5	45.2	0.33						
			SP-SM	127.3	2039	7.6	63.4	0.32						
			SM	130.3	2087	6.5	59.9	0.29						
			SM	128.3	2055	4.6	39.7	0.31						
			SM	118.0	1890	9.0	56.8	0.43						
			SM	123.6	1980	7.4	55.0	0.36						
			SM	131.3	2103	6.1	58.2	0.28						
			SP-SM	134.7	2158	6.3	67.8	0.25						
			SP-SM	131.6	2108	4.3	41.4	0.28						
			SM	134.9	2161	5.2	56.4	0.25						
			SM	134.6	2156	4.5	48.3	0.25						
			SM											
30	14	16	SC											
			SM						136.7	2190	6.8			
			SP-SM											
		NP	SW-SM											
			SM						123.0	1970	10.9			
			ML											
			SM											
			SM											
			SW-SM											
26	15	11	CL											
			SC											
27	17	10	SC											
		NP	SM											
21	18	3	ML						125.5	2010	9.1			

COMPACTED DRY DENSITY (kg/m³)	OPTIMUM MOISTURE (%)	SPECIFIC GRAVITY OF SOLIDS	TRIAXIAL (d)	UNCONFINED COMPRESSION	DIRECT SHEAR	CONSOLIDATION	CHEMICAL	CBR
					*			
2190	6.8							*
1970	10.9						*	*
							*	
2010	9.1						*	*

SUMMARY OF LABORATORY TEST RESULTS
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE 9-1 3 OF 4

WOODWARD-CLYDE CONSULTANTS

AFV-01

ACTIVITY NUMBER	SAMPLE NUMBER (a)	SAMPLE INTERVAL		PERCENT FINER BY WEIGHT									
				STANDARD SIEVE OPENING							U S STANDARD		
				BLDRS.	COBBLES		GRAVEL				SAND		
		FEET	METERS	24"	12"	6"	3"	1½"	3/4"	3/8"	4	10	40
BU-P-16	B-1	0.25-1.5	0.08-0.46				100	93	82	65	53	42	29
BU-P-17	b-1	0.5-2.0	0.15-0.61							100	98	93	65
BU-P-18	B-1	0.5-2.0	0.15-0.61					100	90	83	76	63	36
BU-P-20	B-1	0.5-2.0	0.15-0.61				100	91	71	62	55	46	33
BU-P-22	B-2	4.0-5.0	1.22-1.52					100	74	57	39	28	16
BU-P-24	b-1	0.5-2.0	0.15-0.61						100	97	90	69	27
BU-CS-6	b-1	0.5-2.0	0.15-0.61							100	99	96	72
BU-CS-10	B-1	0.5-2.0	0.15-0.61								100	99	86
BU-CS-20	b-1	0.5-1.5	0.15-0.46						100	95	91	84	67
BU-CS-24	B-1	0.5-2.0	0.15-0.61					100	96	81	57	32	13
BU-CS-28	b-1	0.5-2.0	0.15-0.61						100	99	97	89	67
BU-CS-30	b-1	0.5-2.0	0.15-0.61					100	81	70	62	50	28
BU-CS-37	b-1	0.5-2.0	0.15-0.61							100	99	92	55
BU-CS-43	b-1	0.5-2.0	0.15-0.61						100	99	96	86	54
BU-CS-56	B-1	0.25-2.0	0.08-0.61									100	86
BU-CS-59	B-1	0.5-2.0	0.15-0.61						100	98	96	92	70
BU-CS-61	B-1	0.25-2.0	0.08-0.61					100	83	74	66	55	31
BU-CS-64	B-1	0.25-2.0	0.08-0.61							100	98	92	54
BU-CS-66	B-1	0.5-2.0	0.15-0.61						100	99	95	79	41

NOTES:

(a) Sample types
- SS - Standard split spoon
- P - Pitcher
- D - Fugro Drive
- B,b - Bulk

(b) NP - Not Plastic

(c) USCS - Unified Soil Classification System

(d) * Indicates that test has been performed and results are included in this report

CHECKED BY _____ APPROVED BY _____

SIEVE NO.		PARTICLE SIZE (mm)		ATTERBERG LIMITS (b)			USCS (c)	IN-SITU					COMPACTED			SPECIFIC GRAVITY OF SOLIDS	TRIAXIAL (d)	UNCONFINED COMPRESSION	DIRECT
	SILT OR CLAY							DRY UNIT WEIGHT		MOISTURE CONTENT (%)	SATURATION (%)	VOID RATIO	MAXIMUM DRY DENSITY		OPTIMUM MOISTURE (%)				
0	100	200	.005	.001	LL	PL	PI	(pcf)	(kg/m³)				(pcf)	(kg/m³)					
9	24	20																	
									GC										
5	35	25																	
									SM										
6	23	18																	
									SM										
2	16	11																	
									GP-GM										
3	14	13			42	15	27												
									GC				134.0	2146	7.2				
7	14	12																	
									SP-SM										
2	45	31																	
									SM										
5	53	35																	
									SM				124.5	1994	9.5				
7	40	26																	
									SM										
2	7	5																	
									SW-SM										
7	51	43			34	23	11												
									SC										
3	21	18																	
									SM										
1	38	31																	
									SM										
3	38	30					NP												
									SM										
	61	51	23	11	25	13	12												
									CL							2.63			
3	44	34																	
									SC										
3	23	16																	
									SM										
1	24	16																	
									SM				125.9	2017	7.4				
	25	18																	
									SM										

SUMMARY OF
VERIFICATION

MX SITING
DEPARTMENT OF THE

FUGRO

VOID RATIO	COMPACTED			SPECIFIC GRAVITY OF SOLIDS	TRIAXIAL (d)	UNCONFINED COMPRESSION	DIRECT SHEAR	CONSOLIDATION	CHEMICAL	CBR
	MAXIMUM DRY DENSITY (pcf)	MAXIMUM DRY DENSITY (kg/m^3)	OPTIMUM MOISTURE (%)							
	134.0	2146	7.2							*
	124.5	1994	9.5							*
				2.63						
									*	
	125.9	2017	7.4							*

SUMMARY OF LABORATORY TEST RESULTS
VERIFICATION SITE, BUTLER COP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE 9-1 4 OF 4

WOODWARD-CLYDE CONSULTANTS

AFV-01

BORING NO	SAMPLE NO.	SAMPLE INTERVAL		SOIL TYPE	NORMAL STRESS		MAXIMUM SHEAR STRENGTH	
		FEET	METERS		ksf	kN/m^2	ksf	kN/m^2
BU-B-1	D-3	7.0-8.0	2.13-2.44	SP	1.0	48	1.4	68
					2.0	96	1.9	90
					3.0	144	3.1	150
BU-B-1	D-7	25.0-26.0	7.62-7.92	SP-SM	2.5	120	2.5	122
					5.0	239	4.6	221
					7.5	359	8.2	391
BU-B-1	D-11	60.0-61.0	18.29-18.59	SP-SM	6.0	287	5.8	277
					8.0	383	7.4	354
					12.0	575	9.5	457
BU-B-2	D-4	10.2-10.9	3.11-3.32	SM	1.0	48	1.7	80
					2.0	96	2.7	129
					3.0	144	3.1	149
BU-B-2	P-8	30.0-31.1	9.14-9.48	ML	3.0	144	2.6	126
					6.0	287	4.8	232
					9.0	431	7.8	375
BU-B-3	D-10	40.1-40.8	12.22-12.44	SP-SM	4.0	192	4.2	200
					8.0	383	7.3	350
					12.0	575	10.8	516
BU-B-4	D-4	10.2-10.9	3.11-3.32	SM	1.0	48	2.2	103
					2.0	96	2.9	138
BU-B-4	D-5	15.2-15.9	4.63-4.85	SP-SM	1.5	72	2.0	95
					4.5	215	4.2	199
BU-B-5	D-9	35.0-35.6	10.67-10.85	SM	3.0	144	6.5	312
					6.0	287	9.1	434
					9.0	431	11.3	542

SUMMARY OF DIRECT SHEAR TEST RESULTS
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

TABLE 9-2

FUGRO NATIONAL, INC.

10 AUG 78

FN-TR-28-11

ACTIVITY NO.	SAMPLE NO	SAMPLE INTERVAL		SOIL TYPE	pH	WATER SOLUBLE				CALCIUM CARBONATE
		FEET	METERS			SODIUM	CHLORIDE	SULPHATE	CALCIUM	
						mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
BU-B-2	P-1	0.0-2.7	0.00-0.82	SP-SM	7.5	22	25	11	76	272
	D-6	20.0-21.0	6.10-6.40	ML	7.4	917	959	172	456	1798
	P-12	58.0-59.3	17.68-18.07	SM	7.5	100	118	413	46	156
	D-16	98.0-98.8	29.87-30.11	SM	7.6	49	15	693	27	95
	P-20	144.0-144.9	43.89-44.17	CL	7.5	72	17	24	24	90
BU-B-4	P-1	0.0-2.8	0.00-0.85	SM	6.1	26	15	643	86	251
	D-6	19.0-20.0	5.79-6.10	SM	6.5	331	295	230	29	147
	D-12	70.0-70.8	21.34-21.58	SM	6.8	246	286	545	16	53
	D-16	110.0-110.9	33.53-33.80	SM	6.4	342	295	849	573	1939
BU-T-4	B-1	0.5-2.0	0.15-0.61	SM	6.5	39	10	212	39	140
BU-T-5	B-1	0.5-2.0	0.15-0.61	SM	6.0	76	22	1495	57	198
BU-P-13	B-1	0.25-2.0	0.08-0.61	ML	6.1	32	15	91	70	338
BU-CS-61	B-1	0.25-2.0	0.08-0.61	SM	6.1	16	15	53	63	184

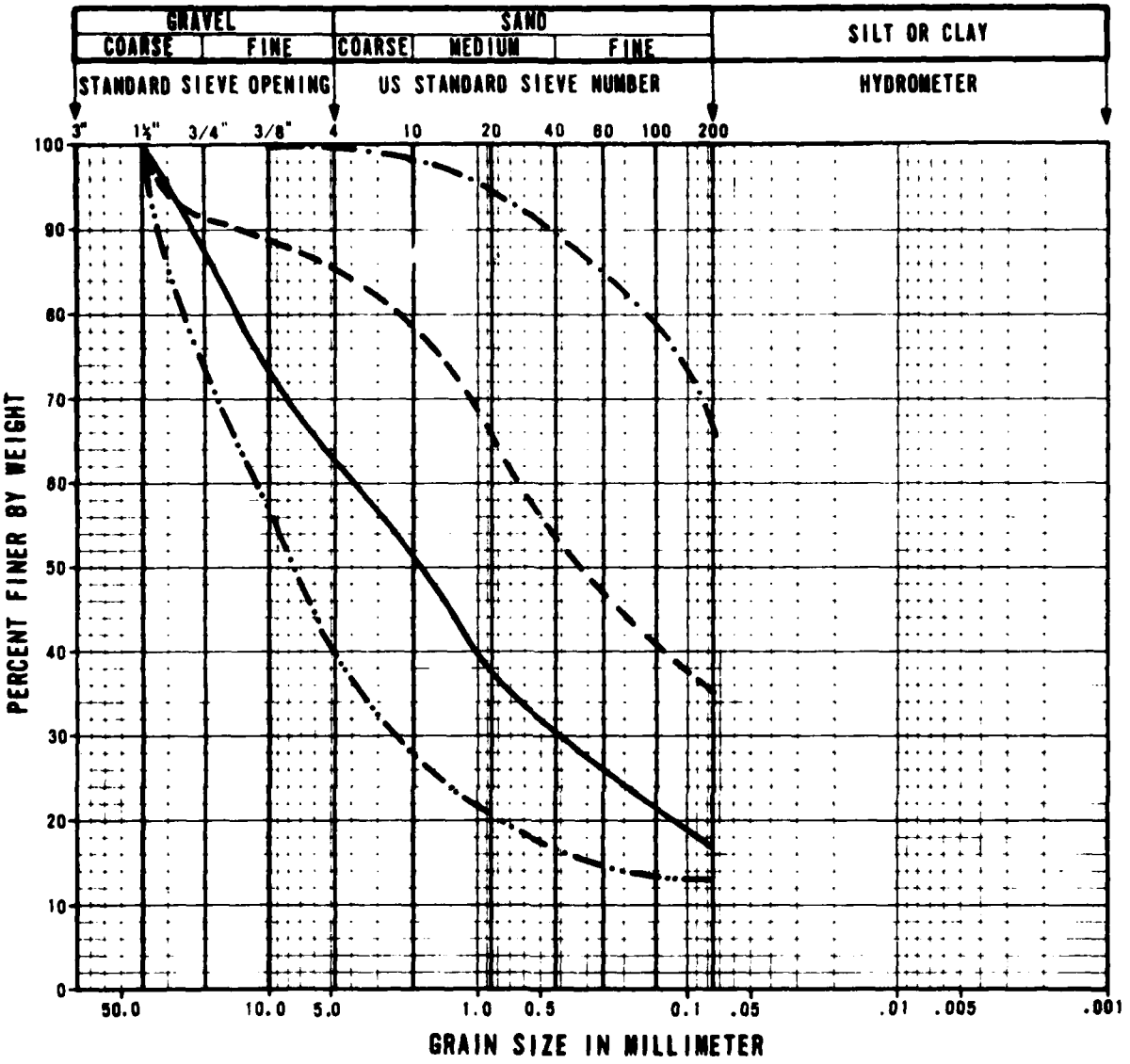
SUMMARY OF CHEMICAL TEST RESULTS
VERIFICATION SITE, BUTLER COP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

TABLE 9-3

WOODWARD-NATIONAL, INC.

AFV-07



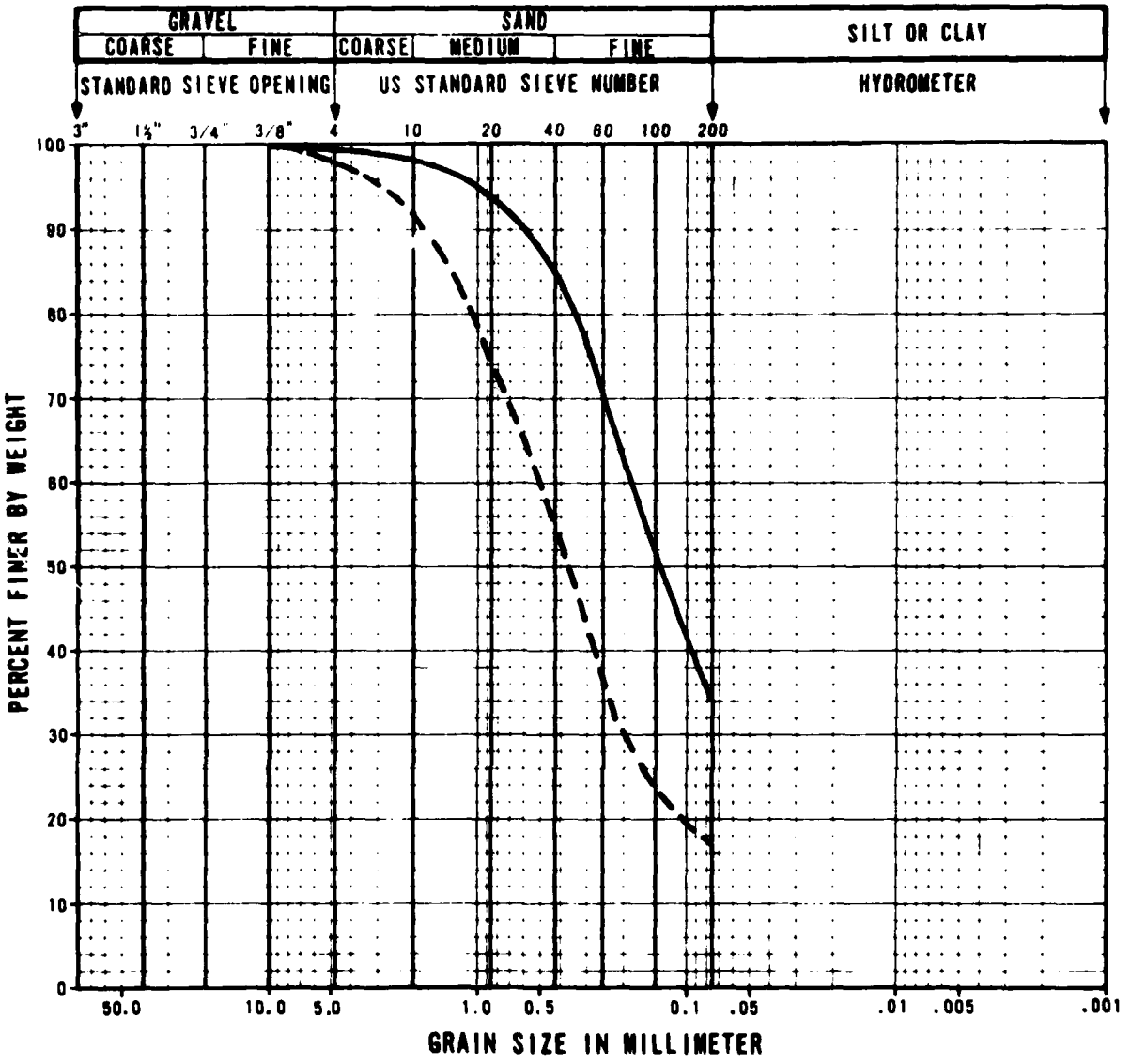
SYMBOL	COMPOSITE SAMPLE NUMBER	ACTIVITY NUMBER	SAMPLE INTERVAL		SOIL TYPE
			FEET	METERS	
———	A	BU-T-2	0.5-2.0	0.15-0.61	SM
— — —	B	BU-T-4	0.5-2.0	0.15-0.61	SM
—·—	C	BU-P-13	0.25-2.0	0.08-0.61	ML
—··—	D	BU-P-22	4.0-5.0	1.22-1.52	GC

GRAIN SIZE CURVES, CBR TESTS
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

FIGURE 9-1 1 OF 2

WOODWARD-CLYDE CONSULTANTS



SYMBOL	COMPOSITE SAMPLE NUMBER	ACTIVITY NUMBER	SAMPLE INTERVAL		SOIL TYPE
			FEET	METERS	
——	E	BU-CS-10	0.5-2.0	0.15-0.61	SM
- - -	F	BU-CS-64	0.25-2.0	0.08-0.61	SM

GRAIN SIZE CURVES, CBR TESTS
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

FIGURE 9-1 2 OF 2

TERRA NATIONAL, INC.

CHECKED BY _____ APPROVED BY _____

10 AUG 79

FN-TR-28-11

COMPOSITE SAMPLE NUMBER	SOIL TYPE	PERCENT PASSING #200	ATTERBERG LIMITS		SPECIFIC GRAVITY	MAXIMUM DRY DENSITY		OPTIMUM MOISTURE (%)	COMPACTED DRY DENSITY		COMPACTED MOISTURE (%)	PERCENT OF MAXIMUM DRY DENSITY	CBR (%)
			LL	PI		pcf	kg/m³		pcf	kg/m³			
A	SM	17				136.7	2190	6.8	132.3	2119	6.1	96.8	90
									125.8	2015	7.4	92.0	45
B	SM	34				123.0	1970	10.9	122.6	1964	11.7	99.6	43
									117.9	1889	11.4	95.8	33
									108.3	1735	11.7	88.0	9
C	ML	66	21	3		125.5	2010	9.1	125.1	2004	9.1	99.7	81
									118.3	1895	9.3	94.3	28
									110.6	1772	9.3	88.1	8
D	GC	13	42	27		134.0	2146	7.2	133.8	2143	6.5	99.9	50
									127.8	2047	6.3	95.4	41
									121.1	1940	6.7	90.4	17

CALIFORNIA BEARING RATIO (CBR) TEST RESULTS
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE 9-4 1 OF 2

WOODWARD-NATIONAL, INC.

AFV-13

10 AUG 79

FN-TR-28-11

COMPOSITE SAMPLE NUMBER	SOIL TYPE	PERCENT PASSING #200	ATTERBERG LIMITS		SPECIFIC GRAVITY	MAXIMUM DRY DENSITY		OPTIMUM MOISTURE (%)	COMPACTED DRY DENSITY		COMPACTED MOISTURE (%)	PERCENT OF MAXIMUM DRY DENSITY	CBR (%)
			LL	PI		pcf	kg/m^3		pcf	kg/m^3			
E	SM	35				124.5	1994	9.5	124.0	1986	9.0	99.6	69
									119.9	1921	8.6	96.3	29
									115.6	1852	8.5	92.9	15
F	SM	16				125.9	2017	7.4	125.9	2017	7.6	100.0	99
									118.7	1901	7.5	94.3	40
									115.4	1849	7.4	91.7	14

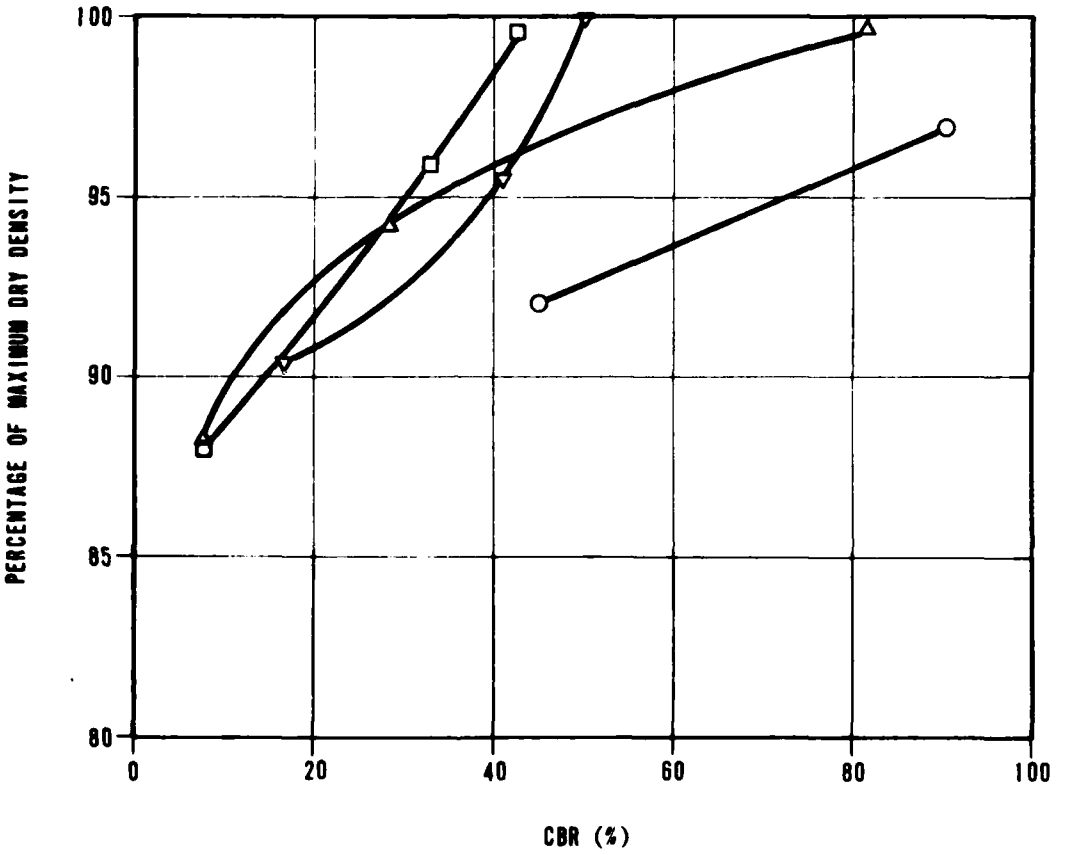
CALIFORNIA BEARING RATIO (CBR) TEST RESULTS
VERIFICATION SITE, BUTLER COP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE 9-4 2 OF 2

TETRA TECH NATIONAL, INC.

AFV-13



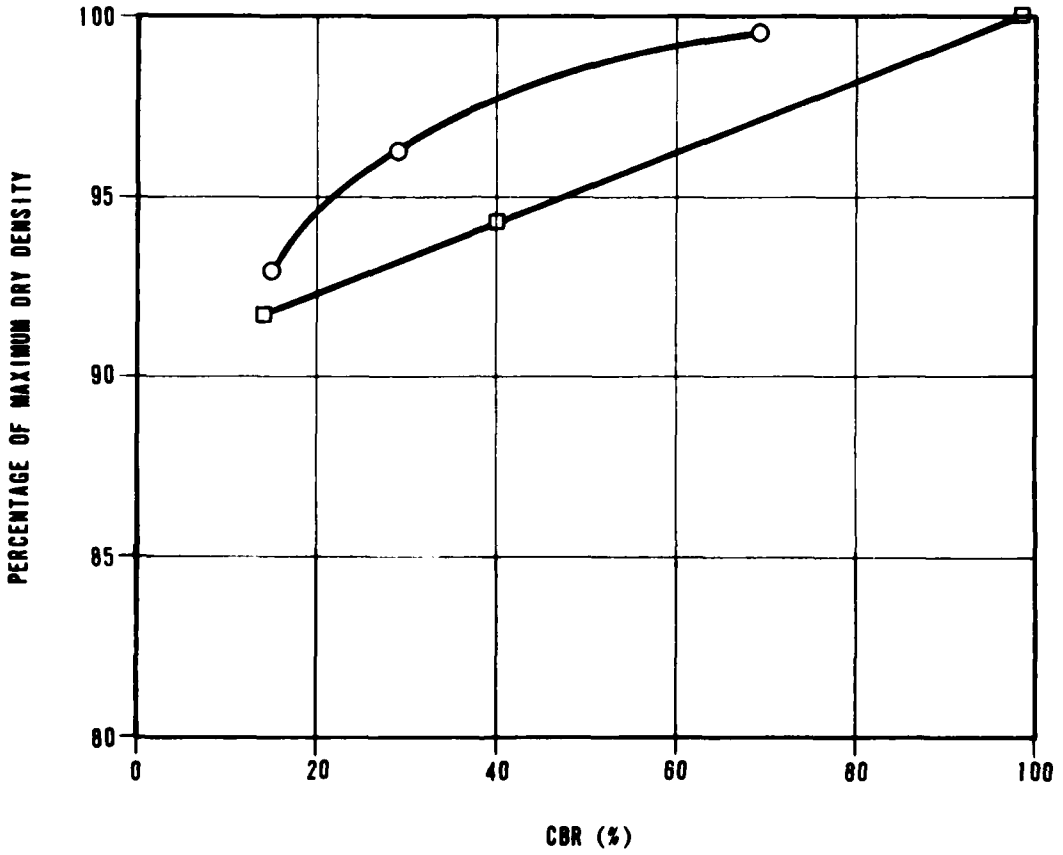
SYMBOL	COMPOSITE SAMPLE NUMBER	SOIL TYPE
○	A	SM
□	B	SM
△	C	ML
▽	D	GC

CALIFORNIA BEARING RATIO (CBR) CURVES
VERIFICATION SITE, BUTLER CDP, ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

FIGURE 9-2 1 OF 2

FUGRO NATIONAL, INC.



SYMBOL	COMPOSITE SAMPLE NUMBER	SOIL TYPE
○	E	SM
□	F	SM

CALIFORNIA BEARING RATIO (CBR) CURVES
VERIFICATION SITE, BUTLER CDP, ARIZONA

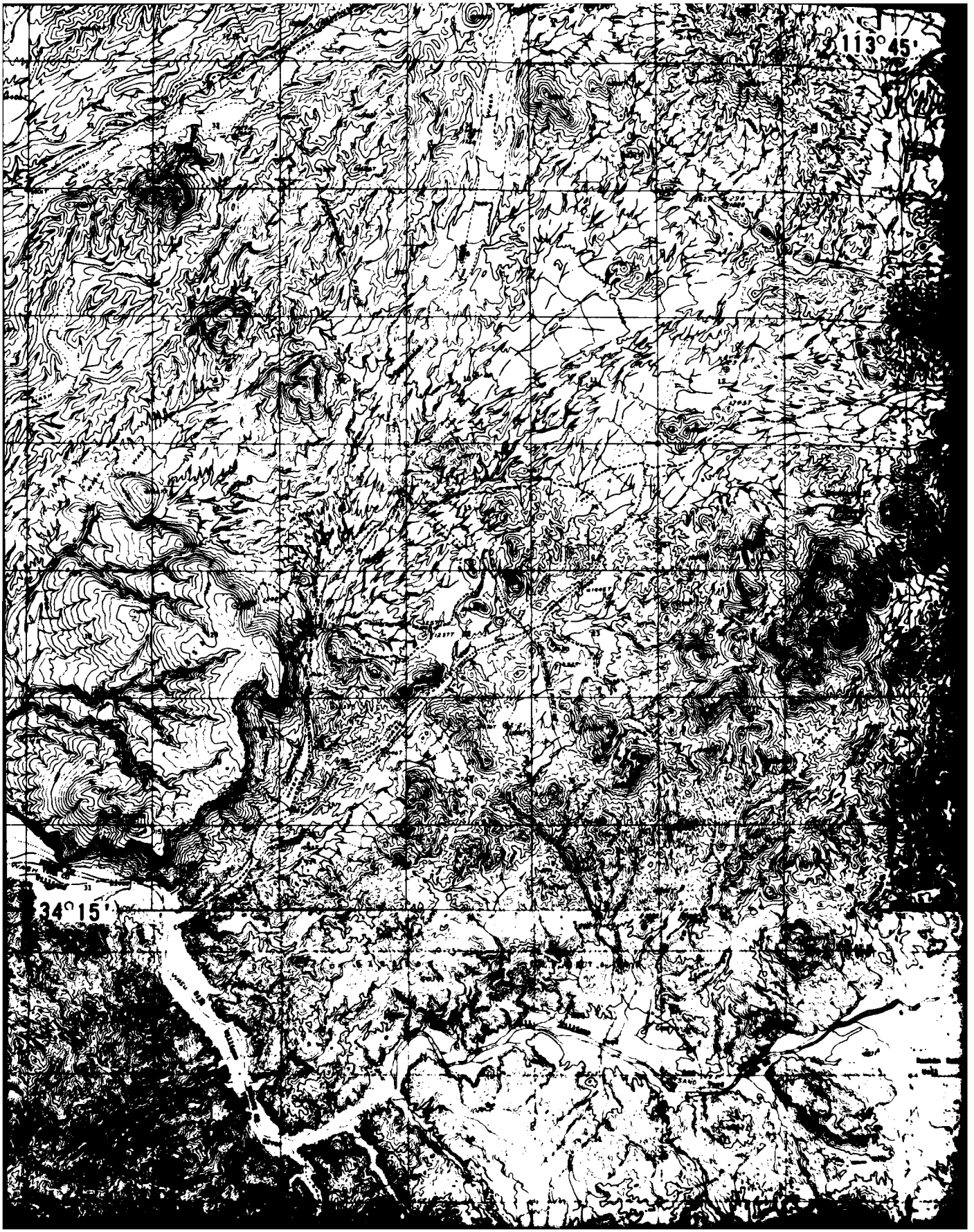
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

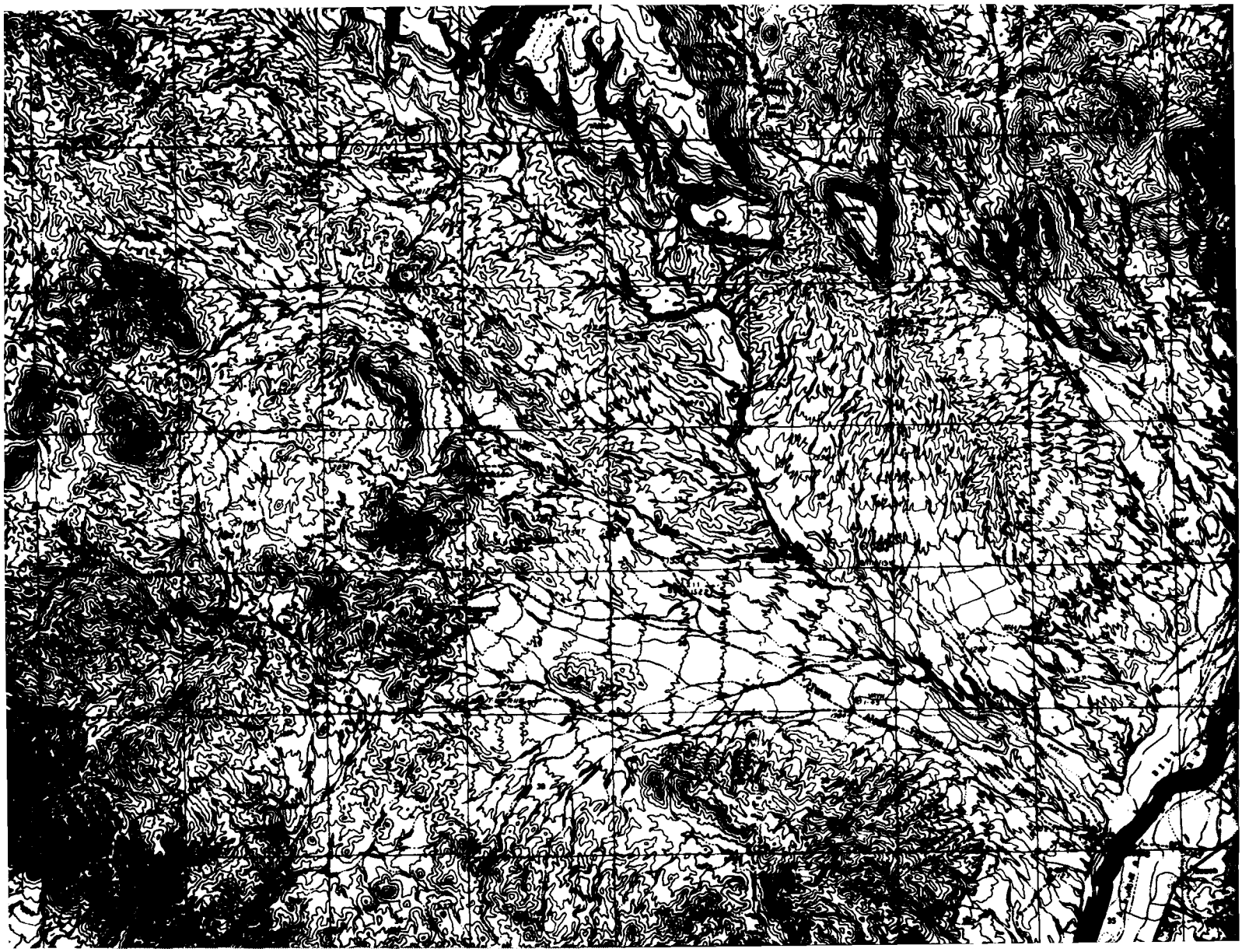
FIGURE 9-2 2 OF 2

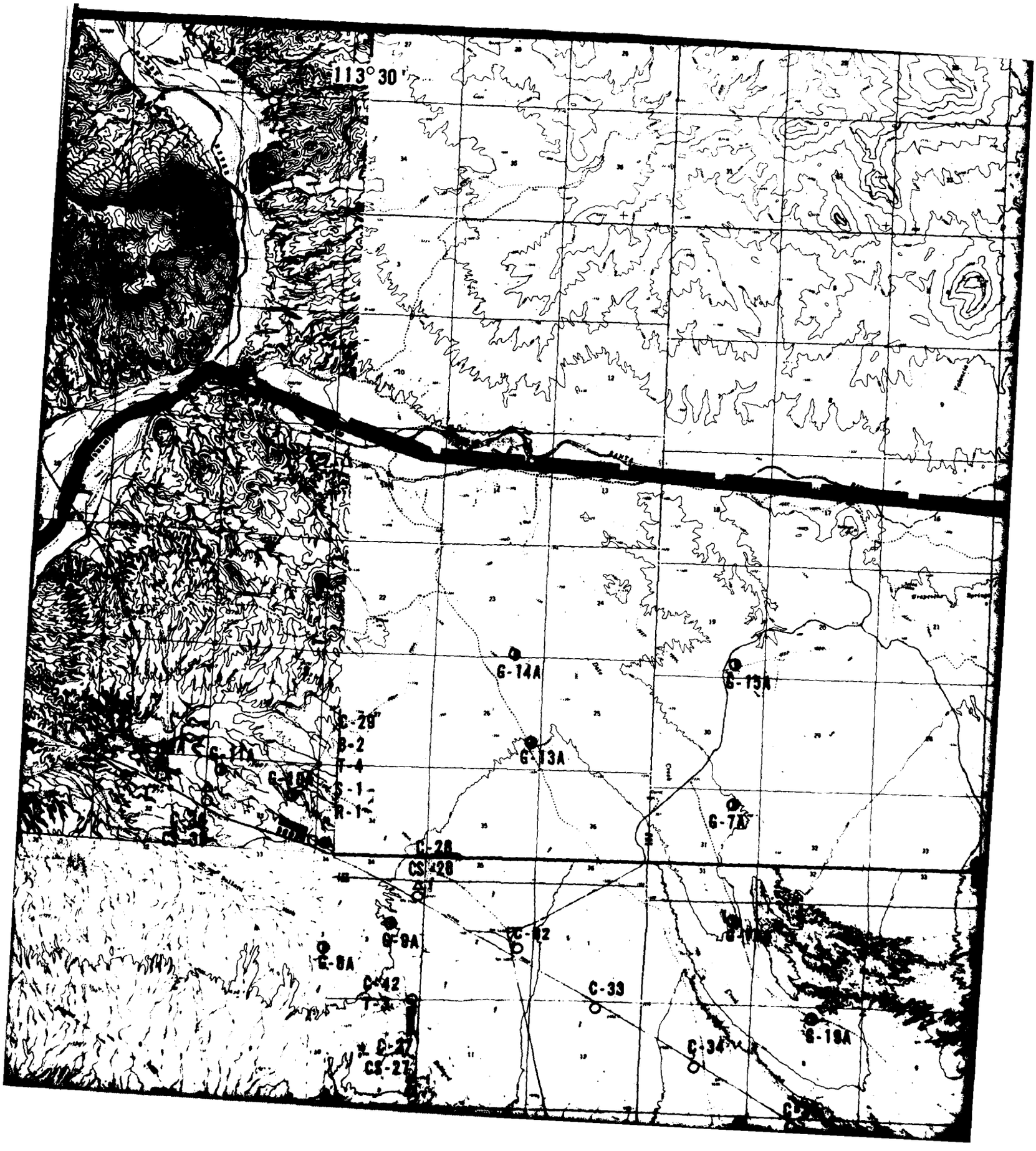
UBRO NATIONAL, INC.

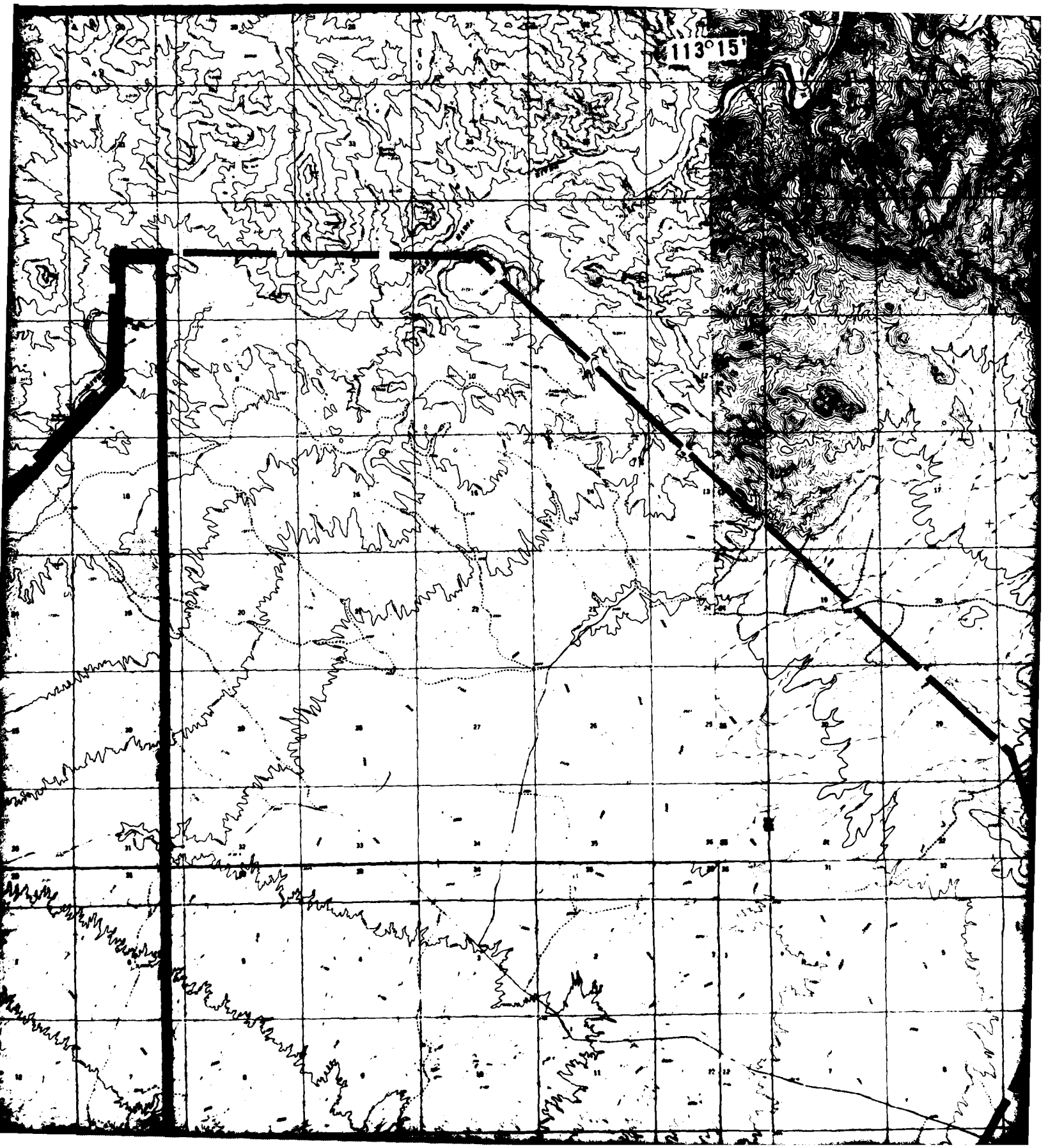
CHECKED BY

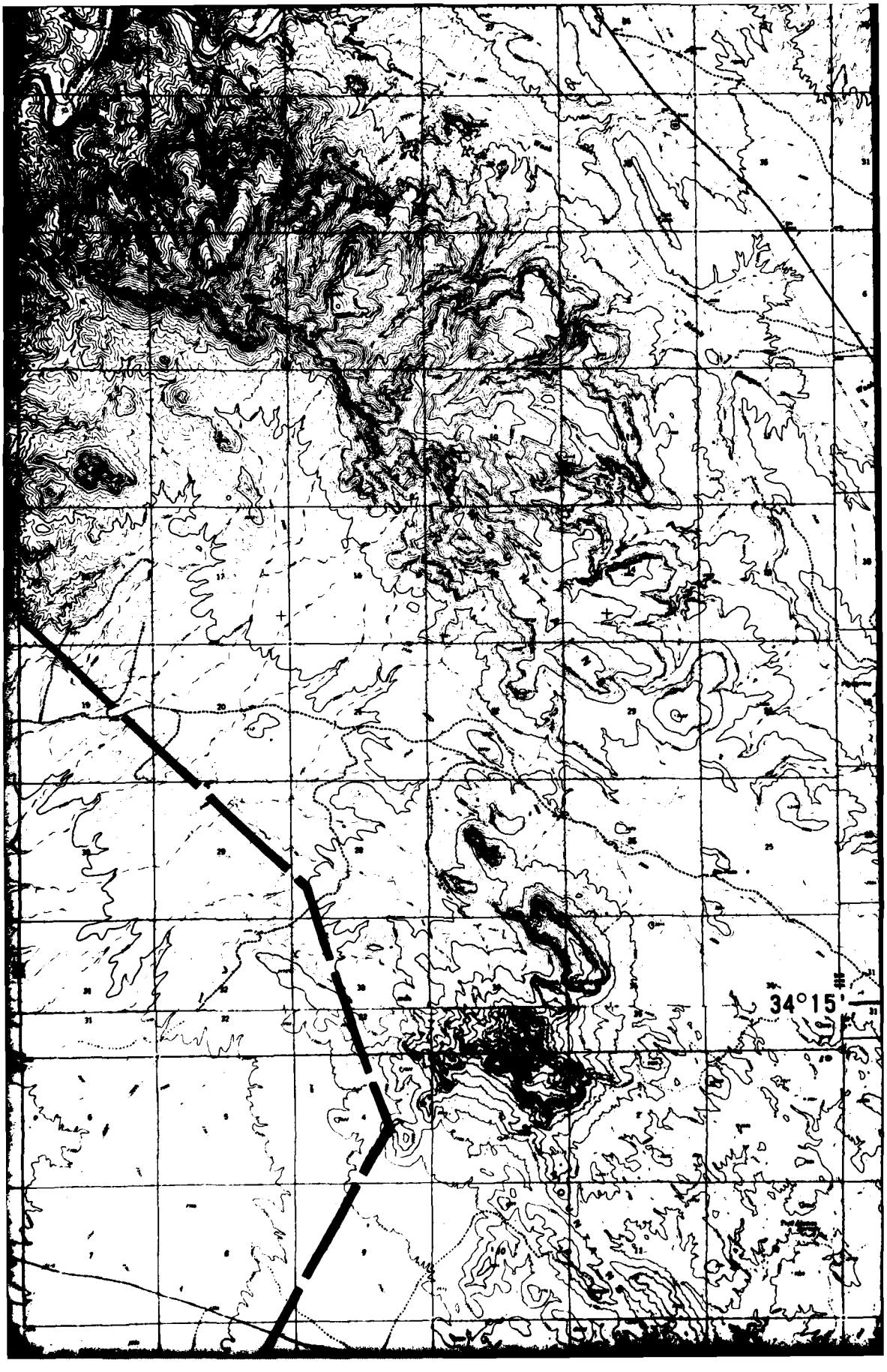
APPROVED BY

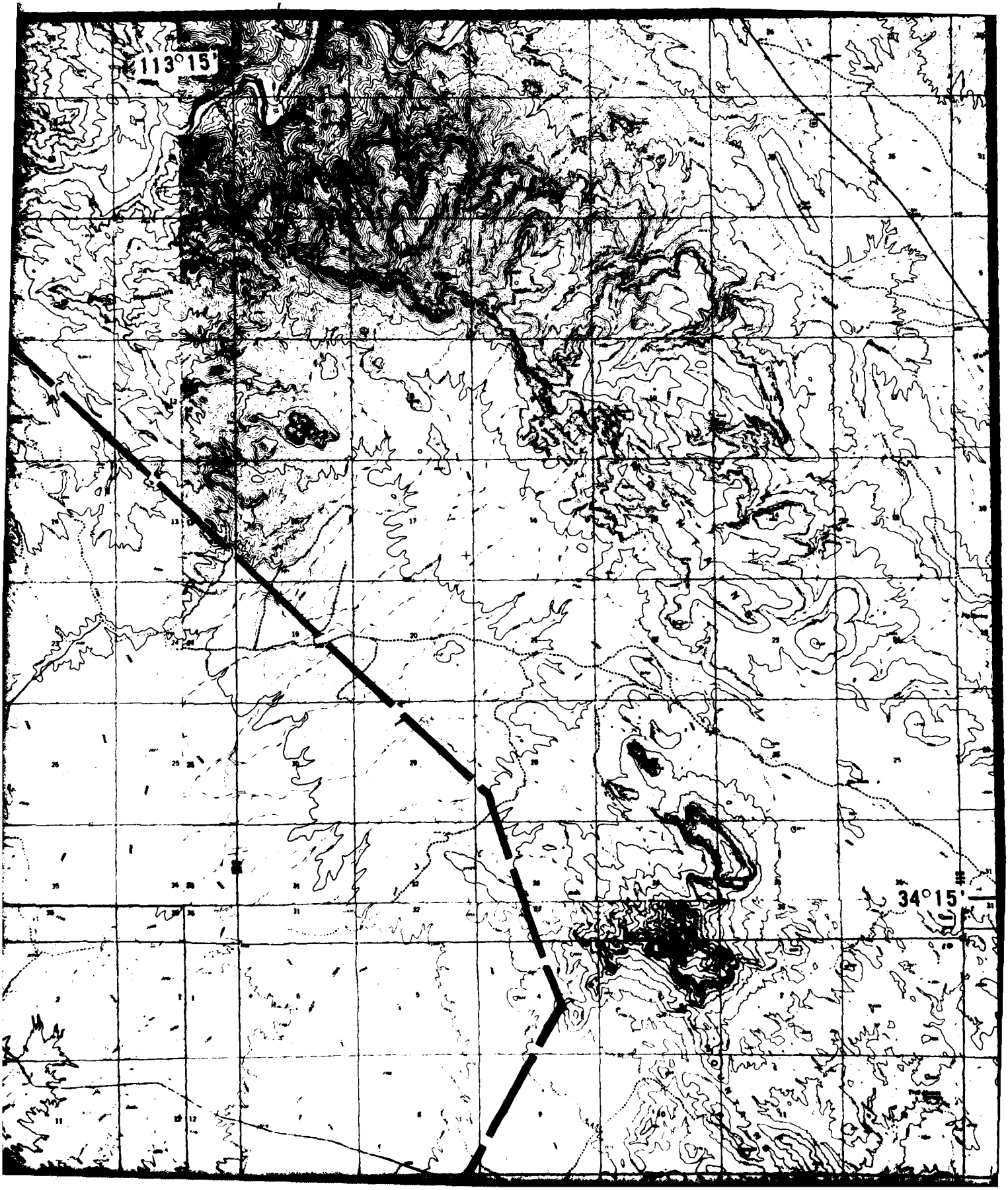

113° 45'
34° 15'

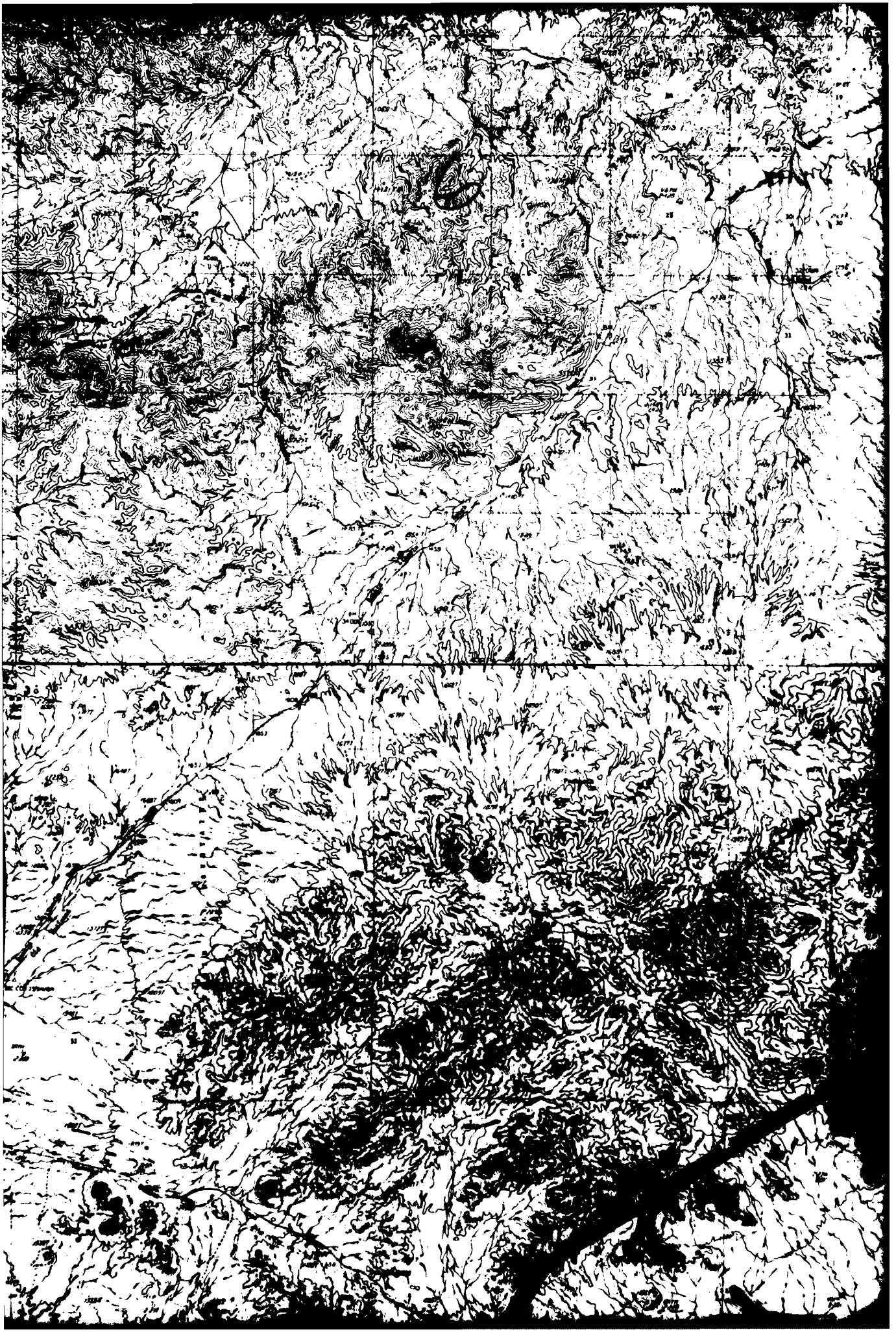



113° 30'
G-14A
G-13A
G-15A
G-7A
G-9A
G-8A
G-19A
C-29
B-2
T-4
S-1
R-1
C-28
CS-28
C-42
C-33
C-34
C-27
CS-27

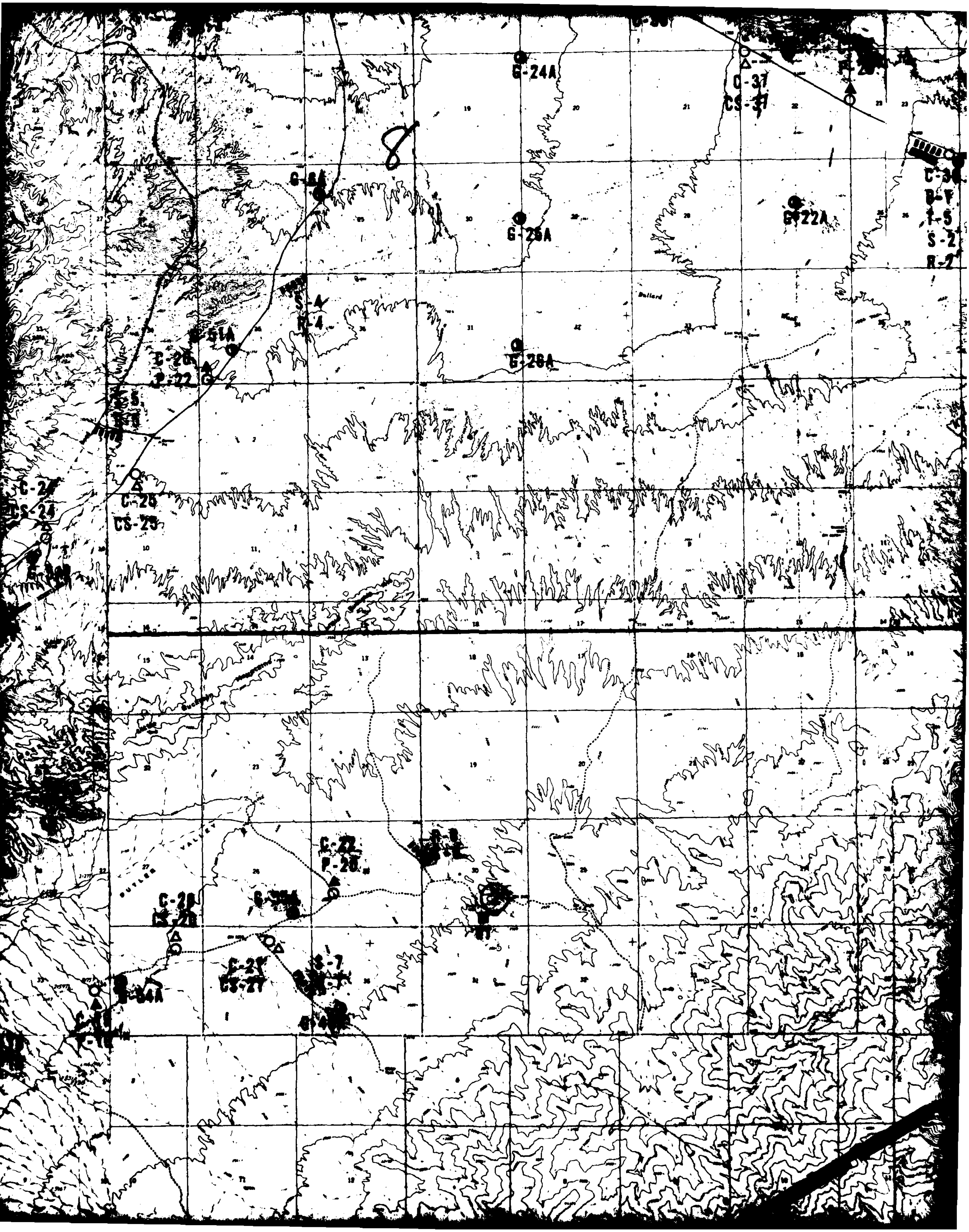

113°15'

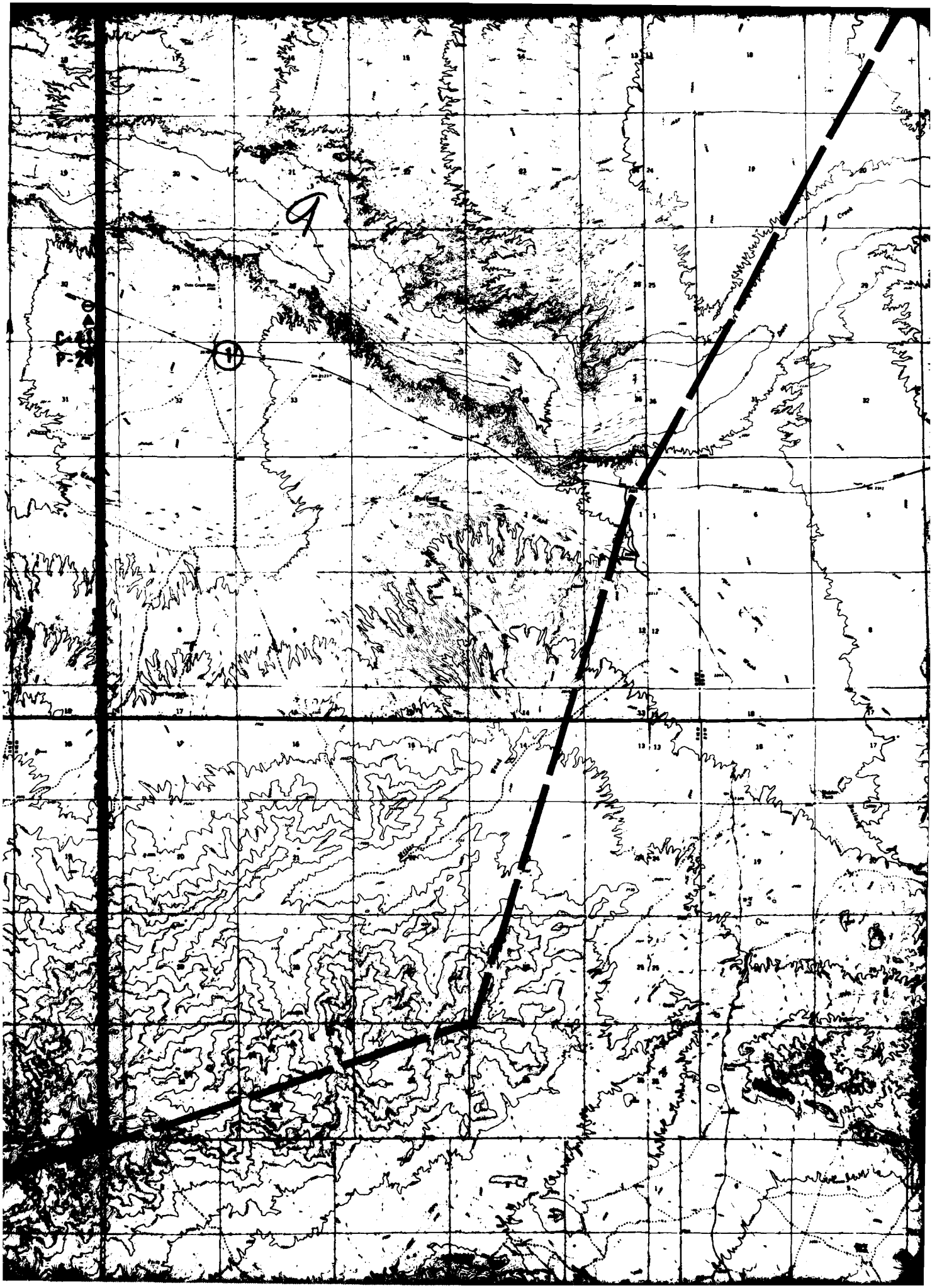

34°15'

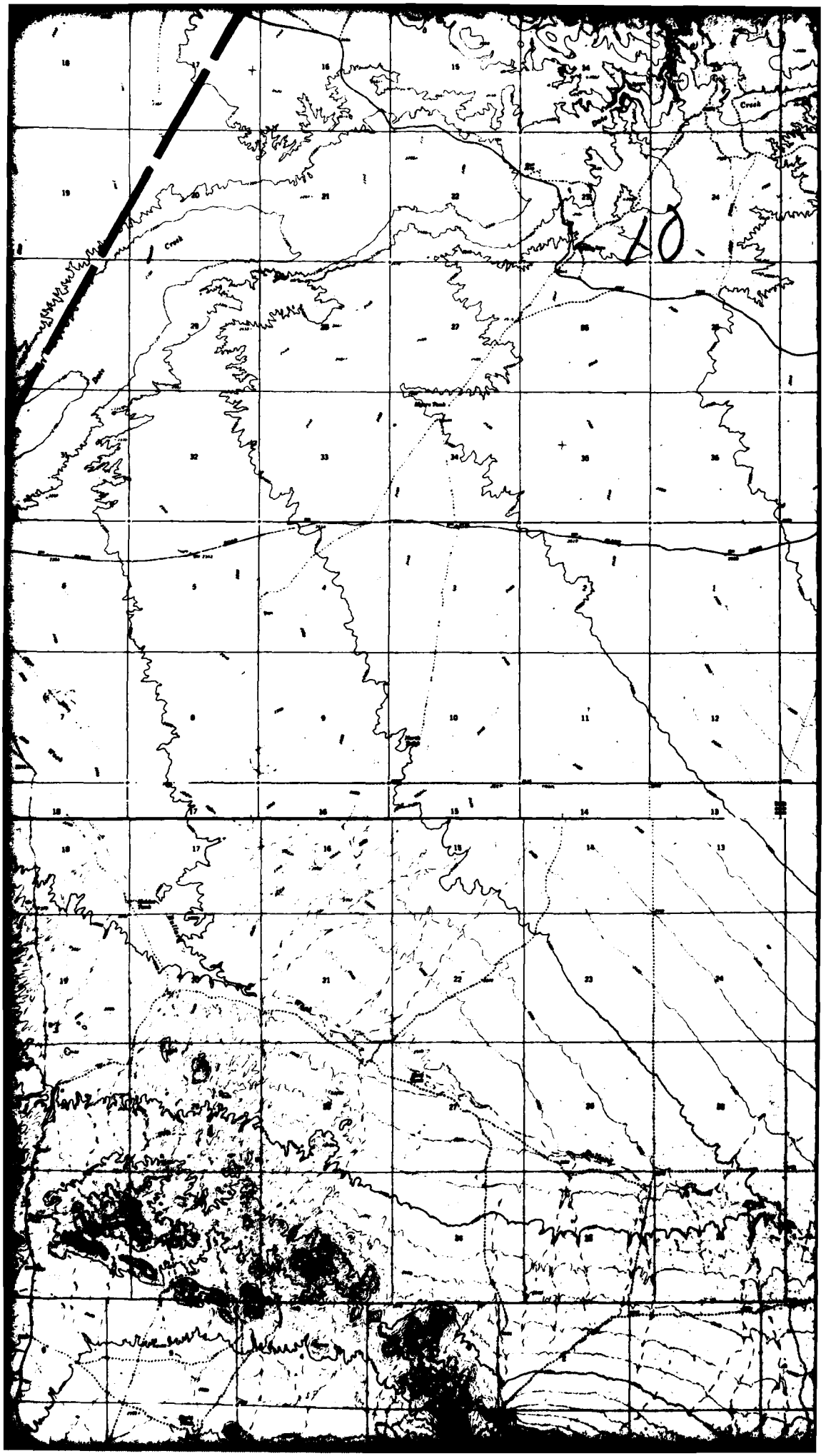

113°15'
34°15'

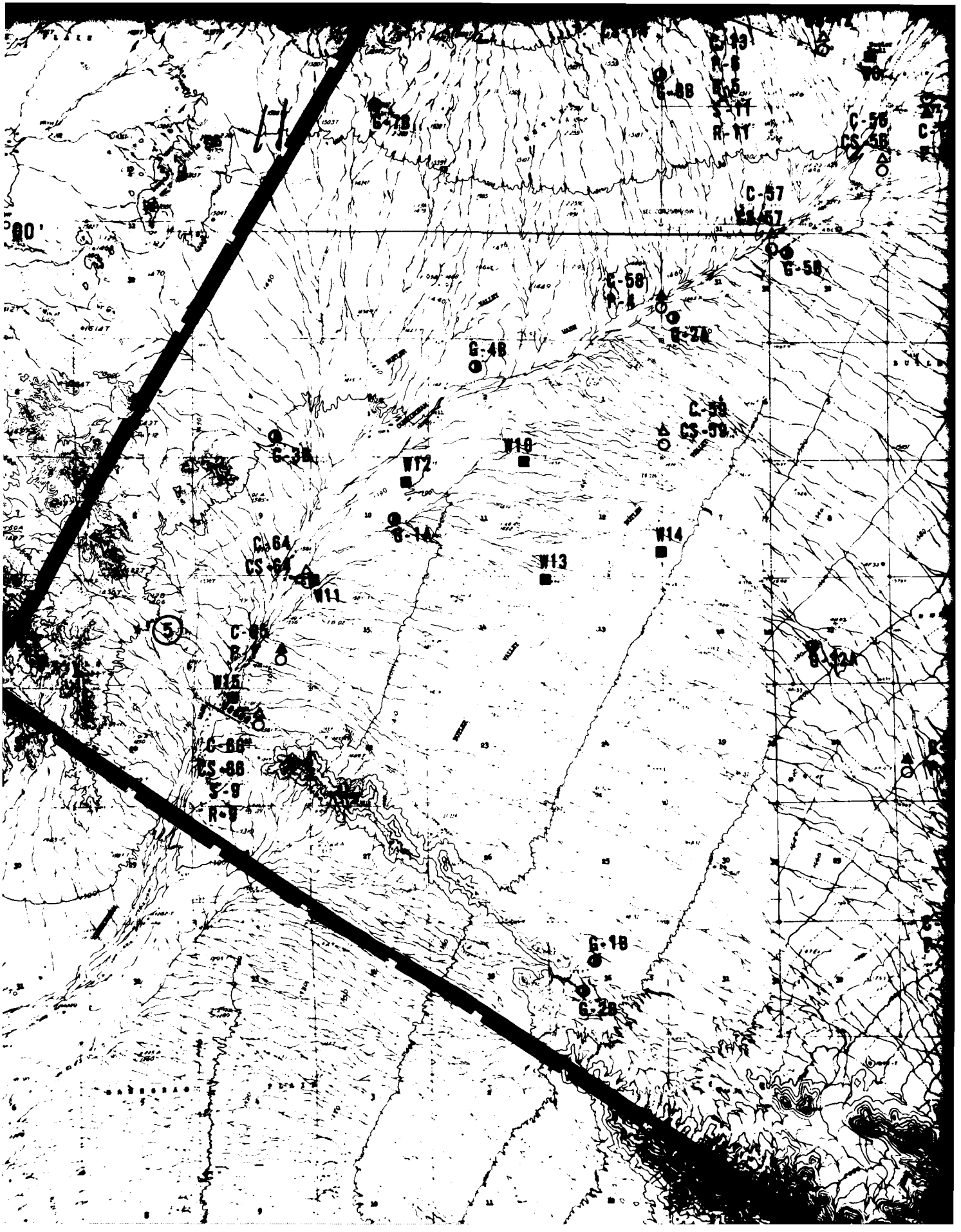


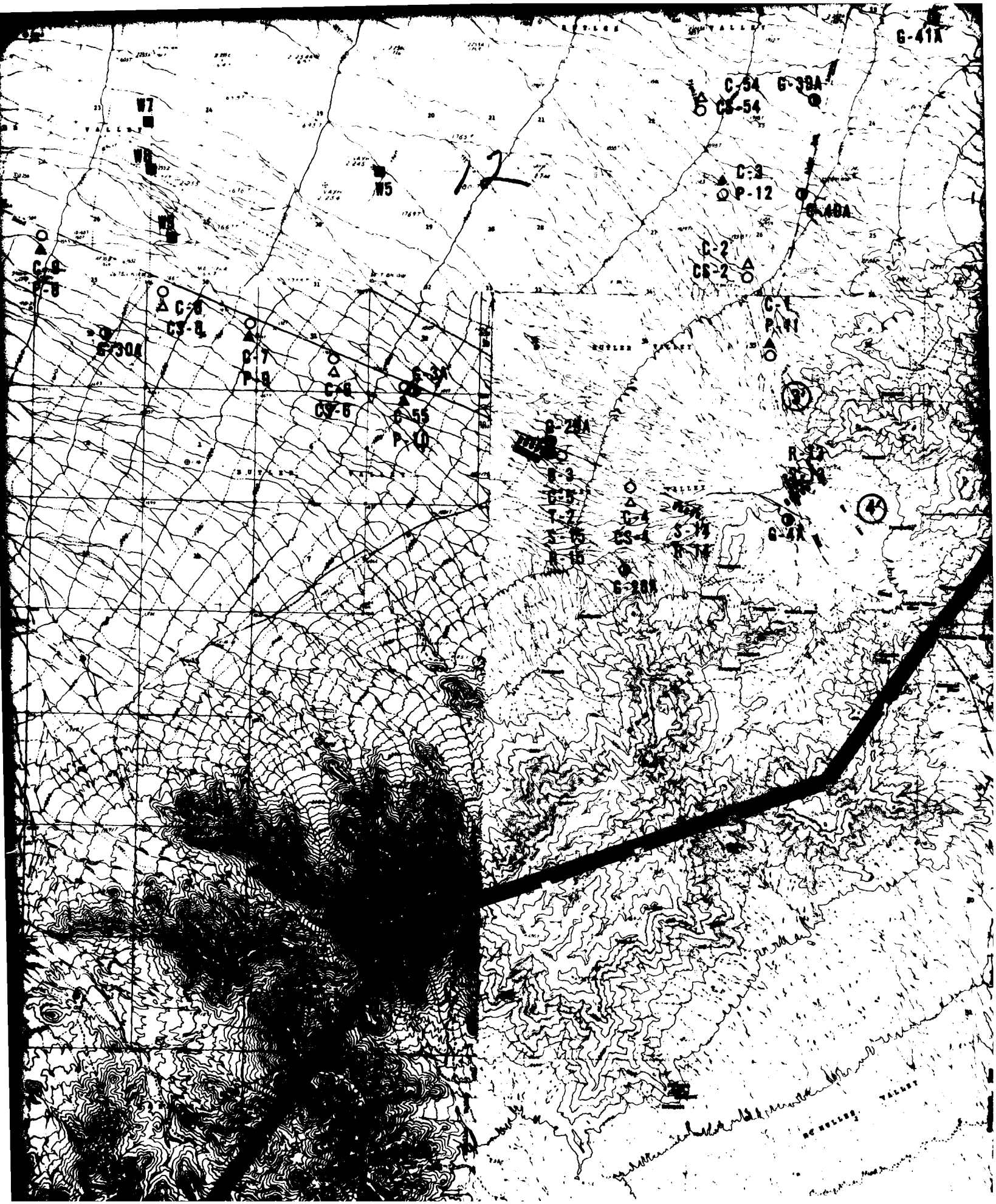

C-37A
C-48
CS-48
C-45
CS-45
C-50
C-51
CS-51
2

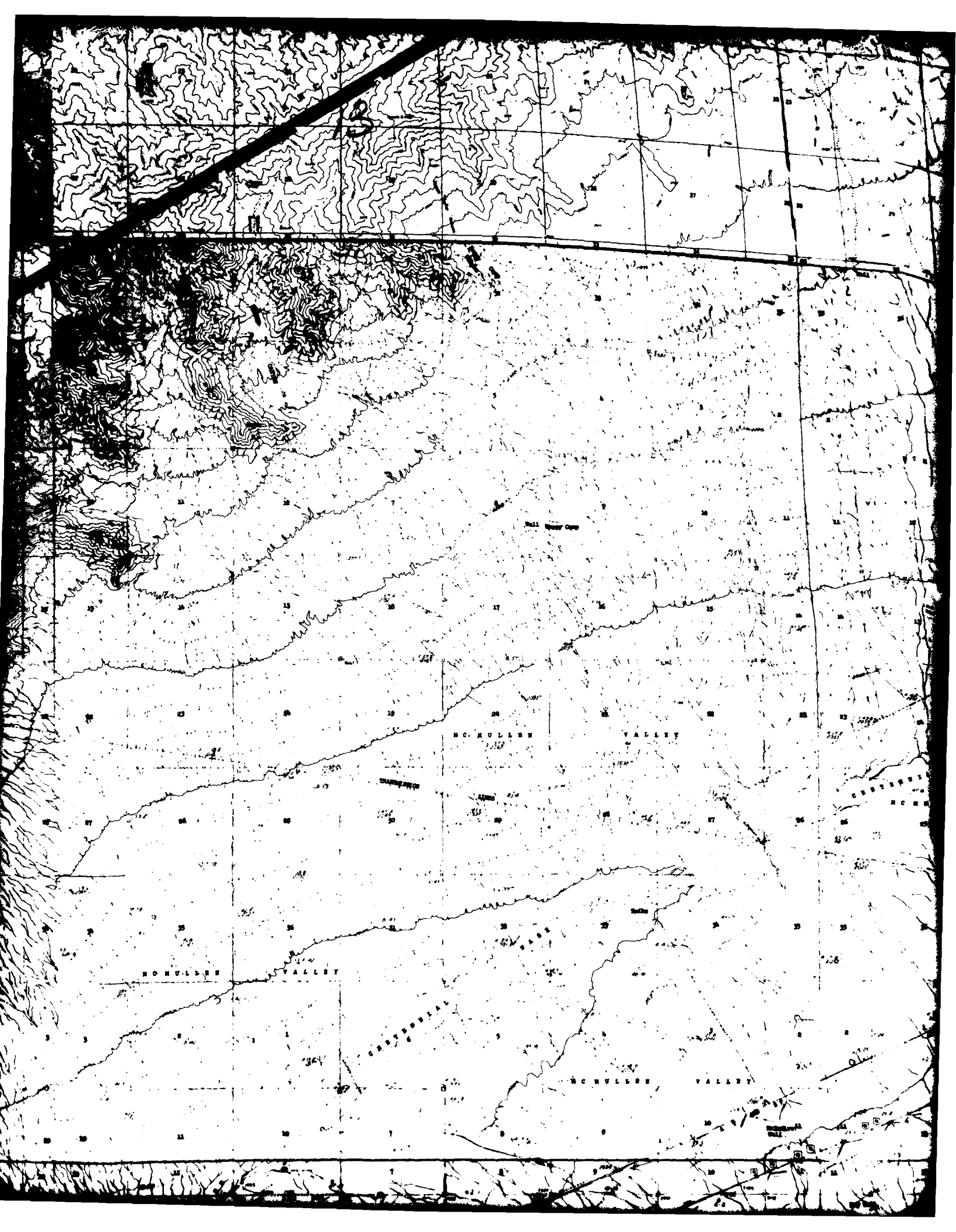

G-24A
C-37
CS-37
8
G-8A
G-25A
G-22A
S-4
R-4
G-26A
Bullard
C-24
CS-24
C-25
CS-25
C-22
P-20
C-28
CS-28
C-27
CS-27
S-7

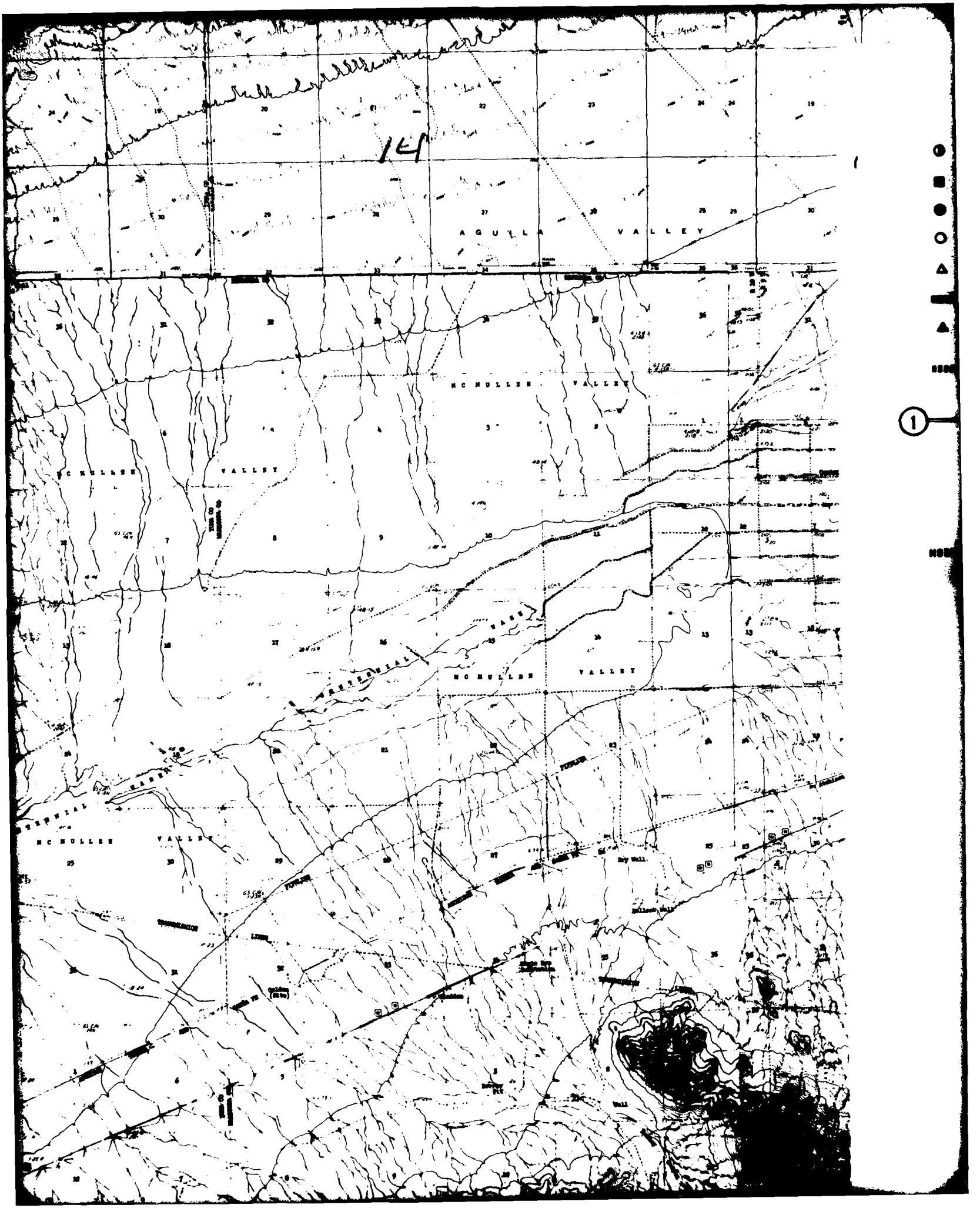


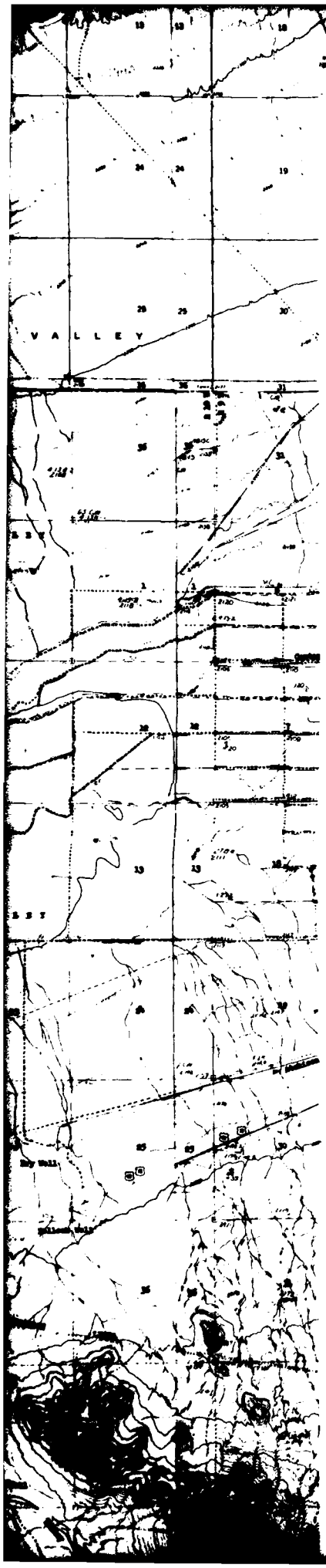



C-13
R-8
G-8B
R-5
R-11
C-56
CS-56
C-57
CS-57
G-5B
C-58
R-8
G-2A
G-4B
C-38
CS-38
W10
W12
C-35
G-14
W14
C-64
CS-64
W13
W11
C-65
R-7
W15
C-66
CS-66
S-9
R-9
G-12A
G-1B
G-2B


G-41A
C-54
CS-54
G-39A
W7
W6
W5
12
C-3
P-12
G-40A
C-2
CS-2
C-1
P-11
C-6
CS-6
G-39A
C-7
P-9
C-8
CS-8
G-55
P-10
G-28A
C-4
CS-4
S-14
P-14
G-41A
G-28A


McCULLOH VALLEY
McCULLOH VALLEY
McCULLOH VALLEY


14
AGUILA VALLEY
MC MULLEN VALLEY
MC MULLEN VALLEY
MC MULLEN VALLEY
MC MULLEN VALLEY
1



EXPLANATION

◑	G-1A	GEOLOGIC STATION
■	WL	GROUND-WATER LEVEL MEASUREMENT
●	B-1	BORING
○	C-1	CONE PENETROMETER TEST (CPT)
△	CS-1	SURFACE SAMPLE AT CPT LOCATION
▬	T-1	TRENCH
▲	P-1	TEST PIT
▪▪▪▪▪	S-1	SEISMIC REFRACTION LINE
	R-1	ELECTRICAL RESISTIVITY LINE
(1)—(1')		ACTIVITY LINE

15

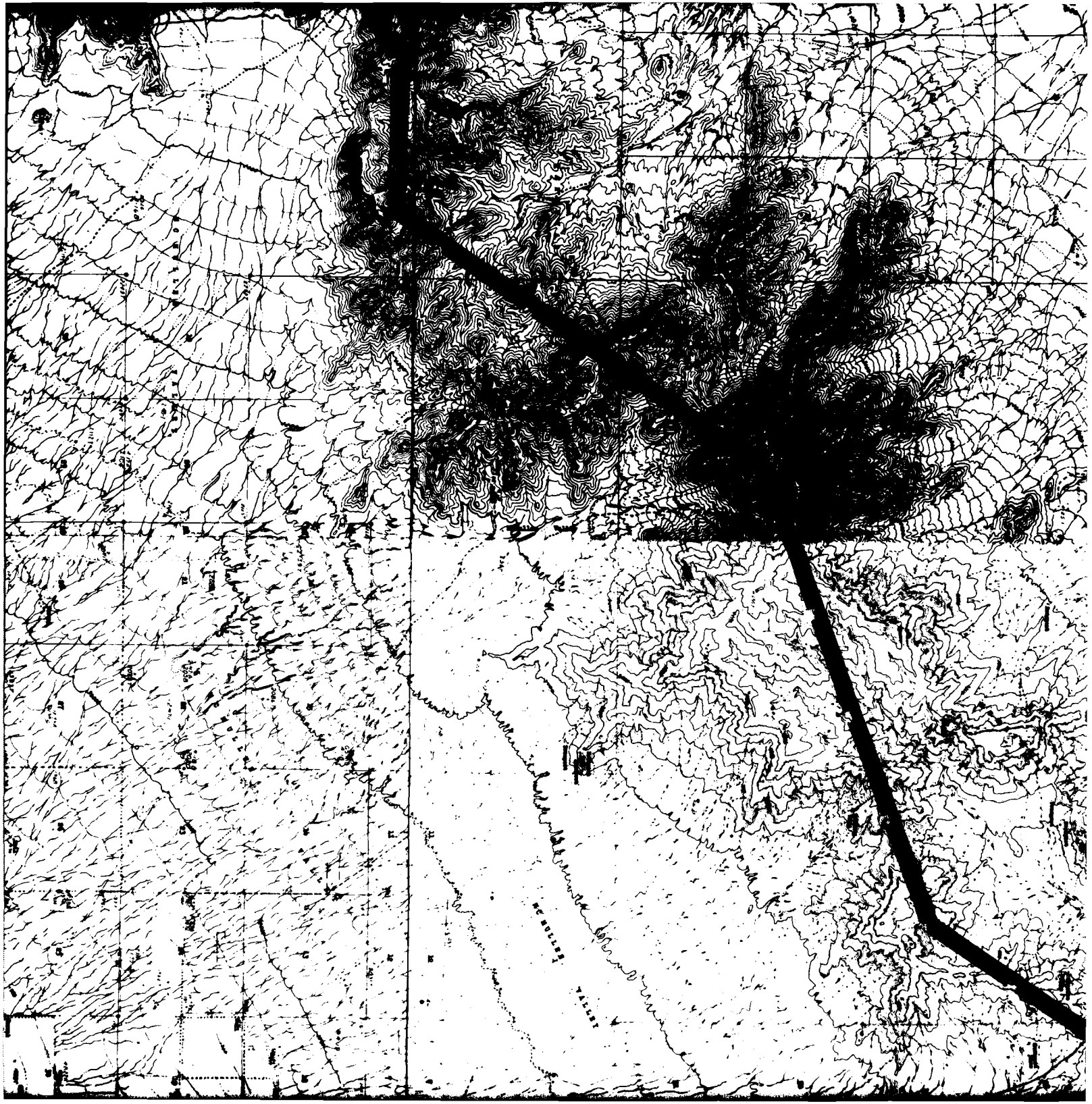
34°00'

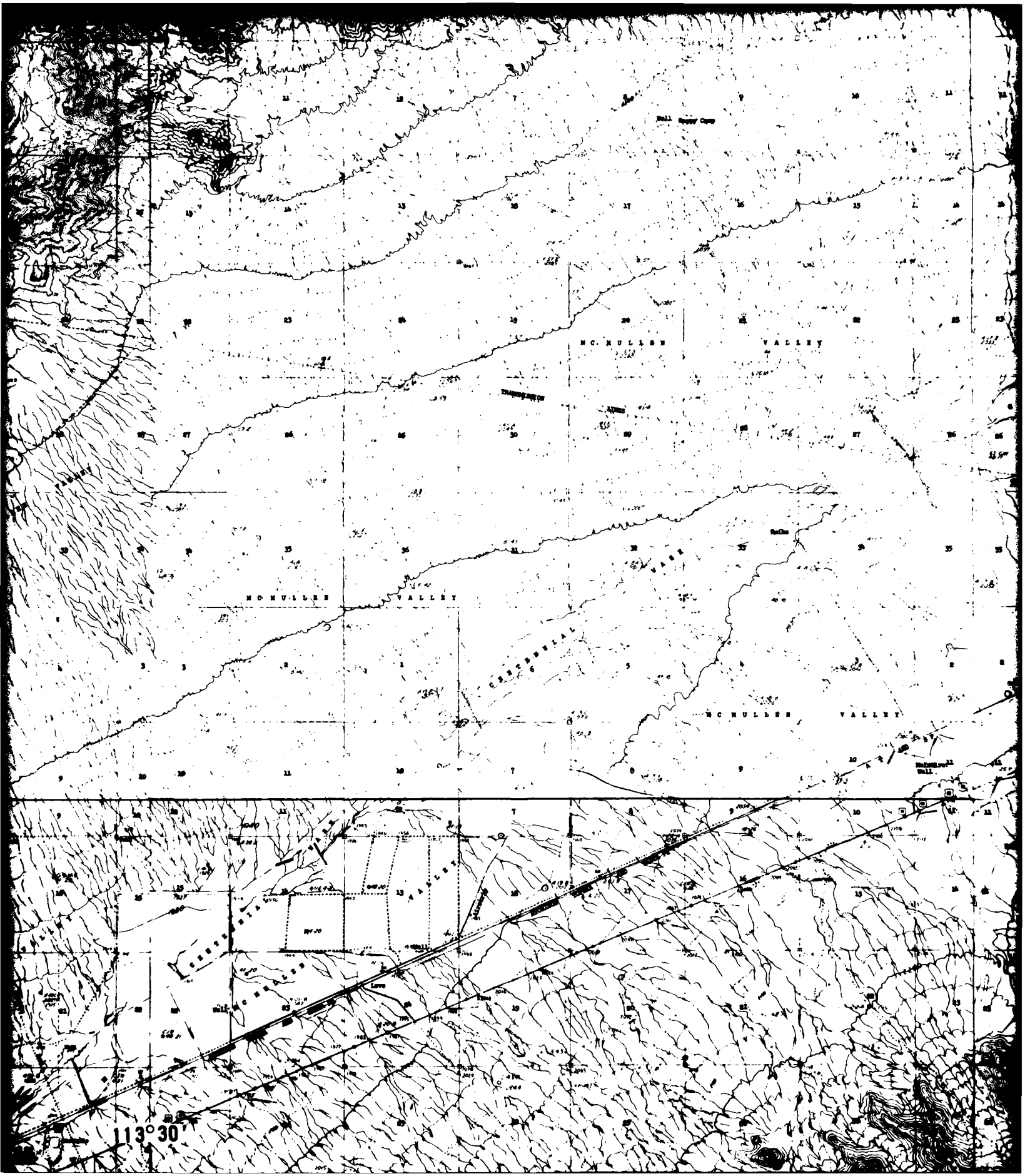
NOTE: Where multiple activities were performed at the same location, the correct location is designated by either (1) the boring symbol or (2) the CPT symbol, if no boring was drilled.

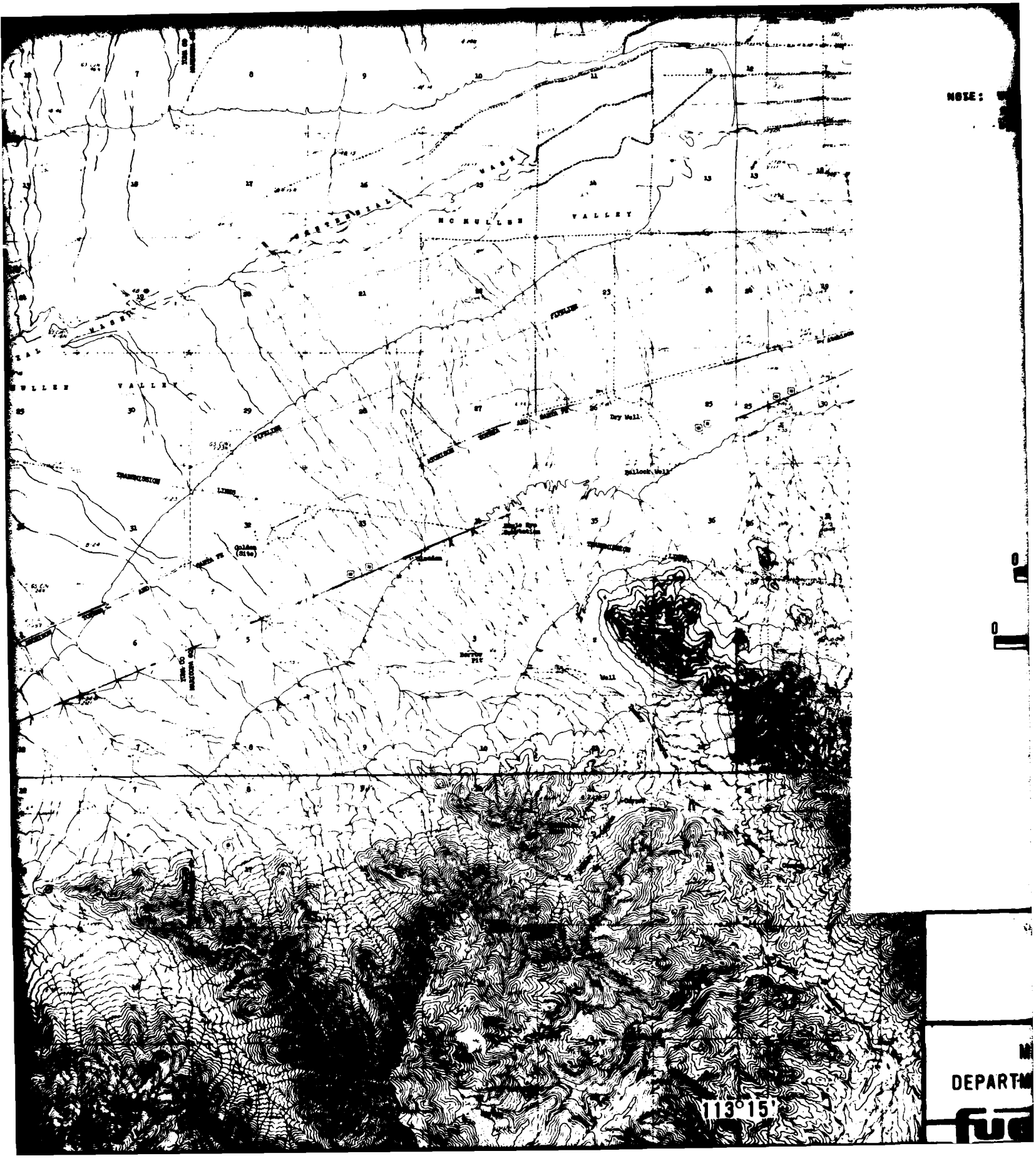
LOCATION MAP

SCALE 1:62,500


W14
W13
W11
C-84
CS-84
C-85
B
W15
C-86
CS-86
V-9
R-9
G-1B
G-2B
113° 45'


MC KELLAR
TALLENT


MC MULLEN VALLEY
MC MULLEN VALLEY
MC MULLEN VALLEY
MC MULLEN VALLEY
CENTENNIAL
113° 30'


NOTE:
VALLEY
Dry Well
Pollock Well
Golden (Site)
Well
113°15'

NOTE: Where multiple activities were performed at the same location, the easiest location is designated by either (1) the boring symbol or (2) the CPT symbol, if no boring was drilled.

LOCATION MAP

SCALE 1:62,500

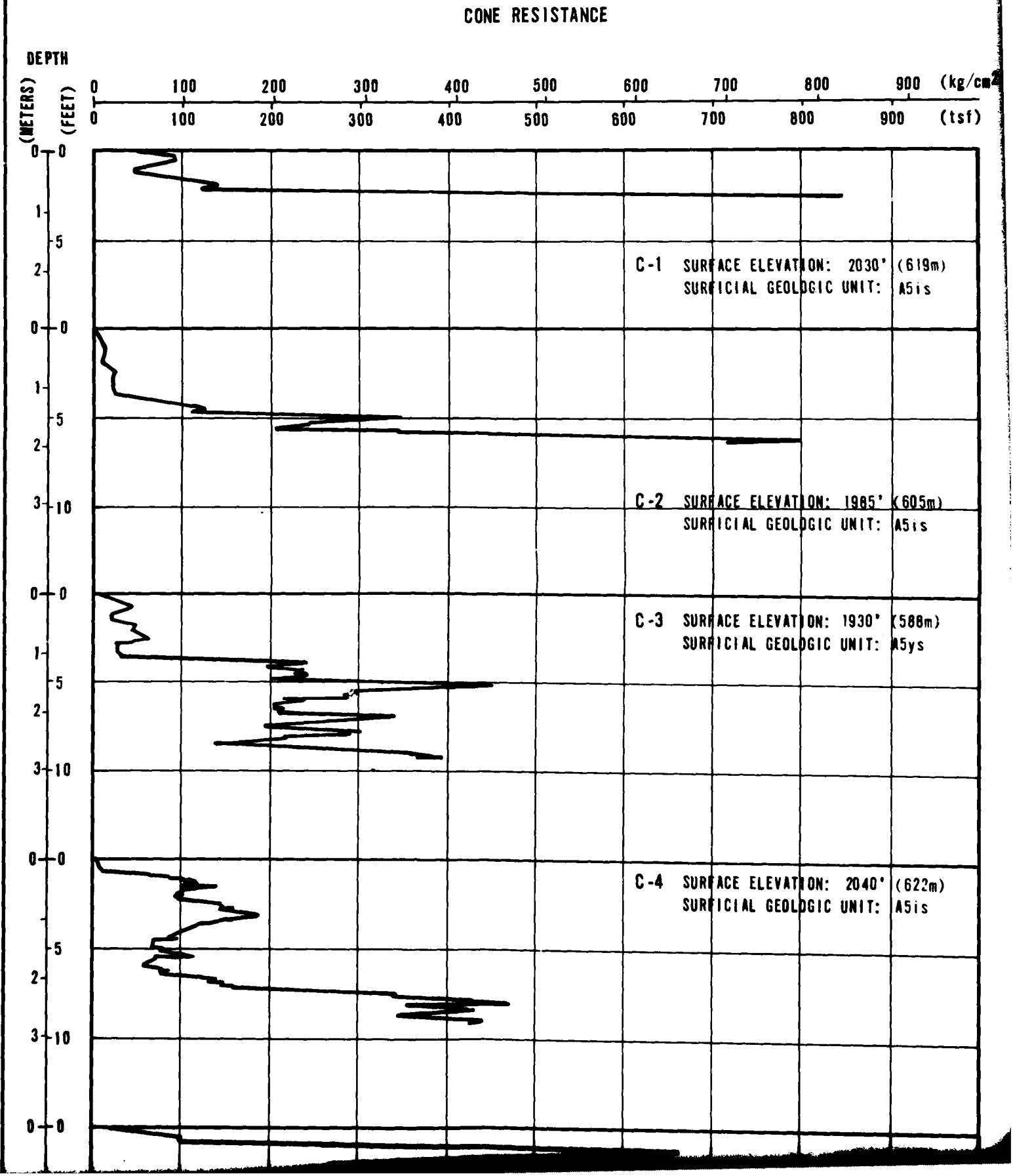
ACTIVITY LOCATION MAP
BUTLER CDP. ARIZONA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

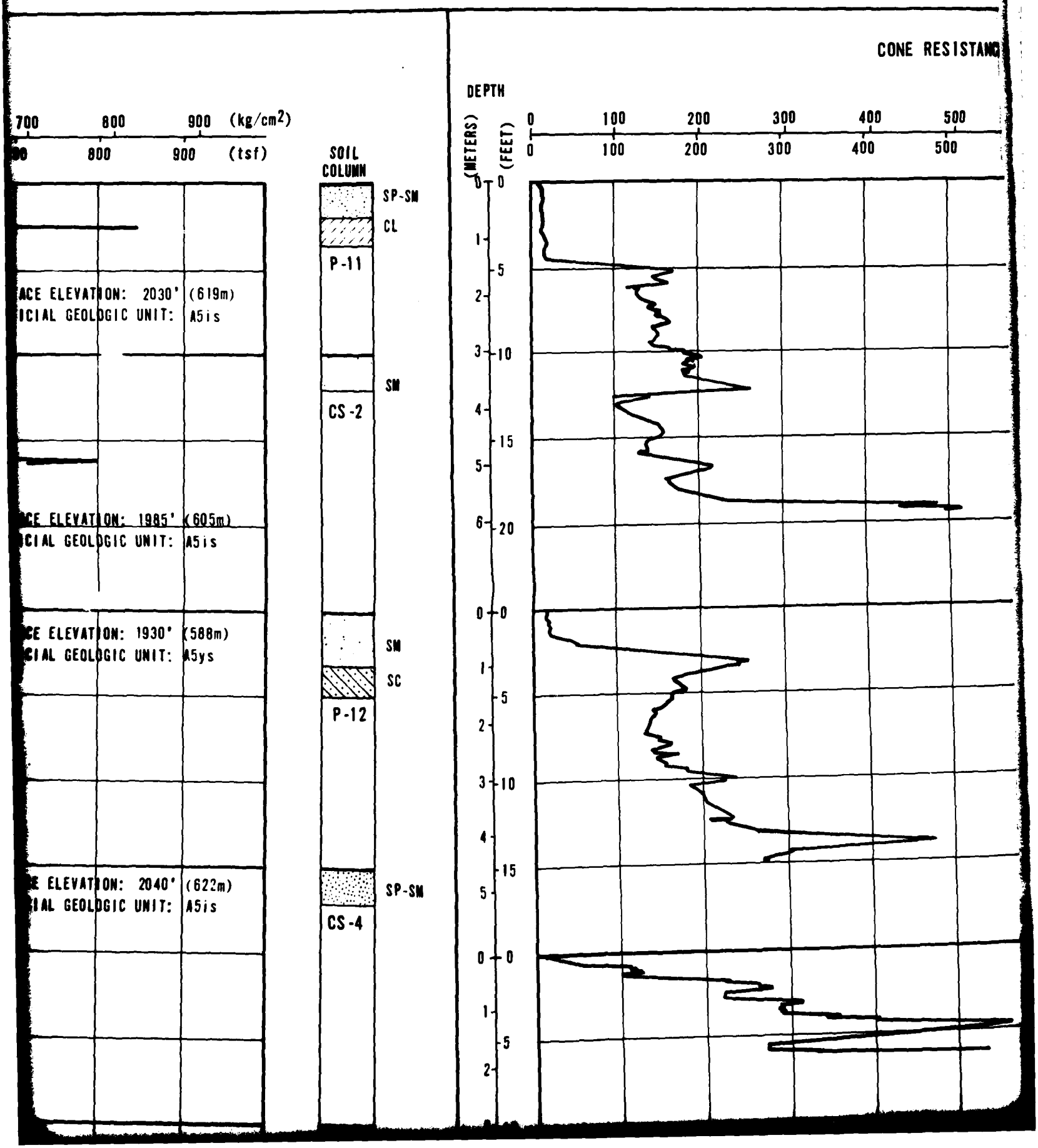
DRAWING
1

FUGRO NATIONAL, INC.

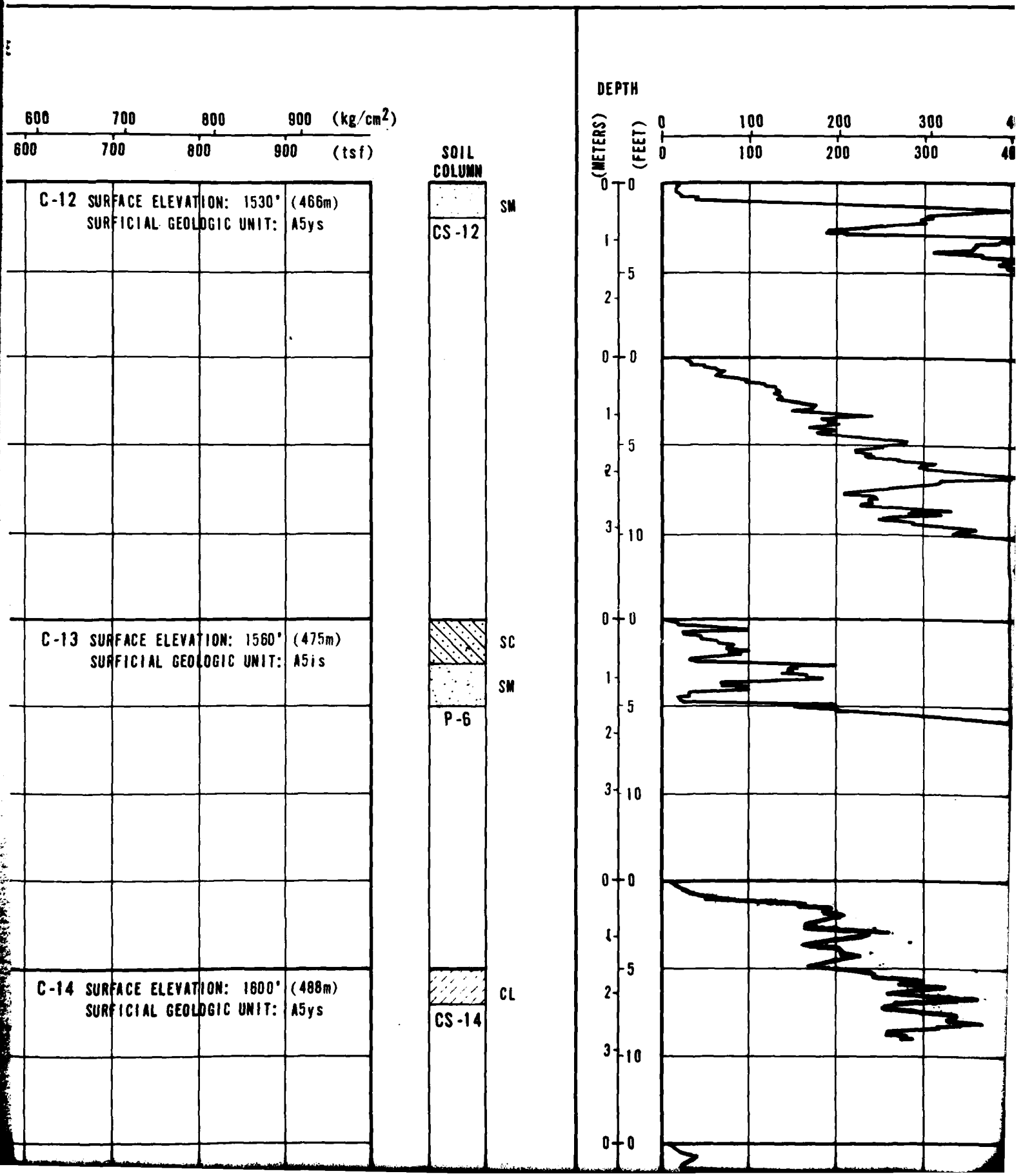
FN-TR-28-11


CONE RESISTANCE
DEPTH
(METERS)
(FEET)
0 100 200 300 400 500 600 700 800 900 (kg/cm²)
0 100 200 300 400 500 600 700 800 900 (tsf)
C-1 SURFACE ELEVATION: 2030' (619m)
SURFICIAL GEOLOGIC UNIT: A5is
C-2 SURFACE ELEVATION: 1985' (605m)
SURFICIAL GEOLOGIC UNIT: A5is
C-3 SURFACE ELEVATION: 1930' (588m)
SURFICIAL GEOLOGIC UNIT: A5ys
C-4 SURFACE ELEVATION: 2040' (622m)
SURFICIAL GEOLOGIC UNIT: A5is

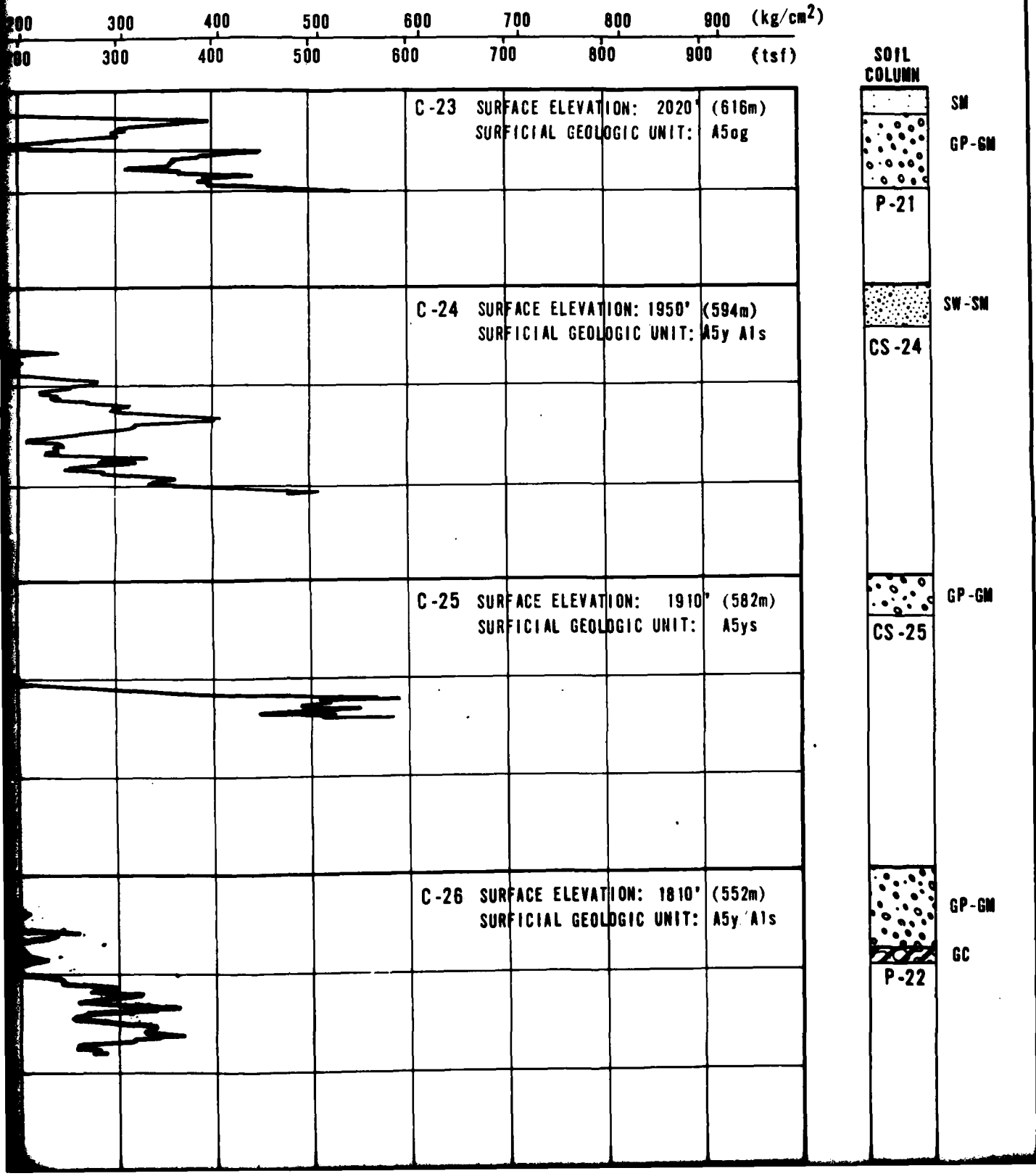
2

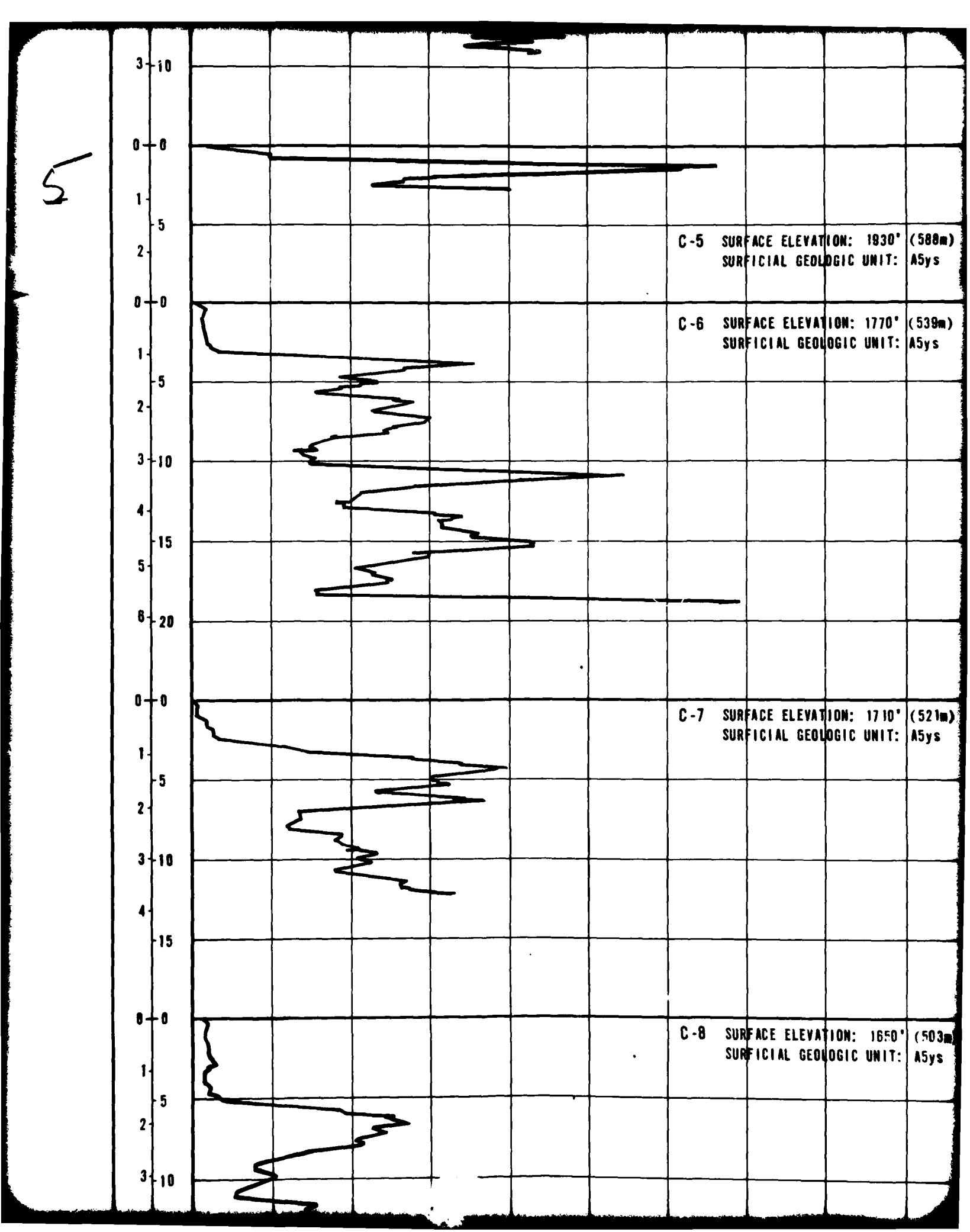

CONE RESISTANC
DEPTH
(METERS)
(FEET)
0
100
200
300
400
500
700
800
900
(kg/cm2)
800
900
(tsf)
SOIL COLUMN
SP-SM
CL
P-11
SM
CS-2
SM
SC
P-12
SP-SM
CS-4
ACE ELEVATION: 2030' (619m)
ICIAL GEOLOGIC UNIT: A5is
CE ELEVATION: 1985' (605m)
CIAL GEOLOGIC UNIT: A5is
CE ELEVATION: 1930' (588m)
CIAL GEOLOGIC UNIT: A5ys
E ELEVATION: 2040' (622m)
IAL GEOLOGIC UNIT: A5is

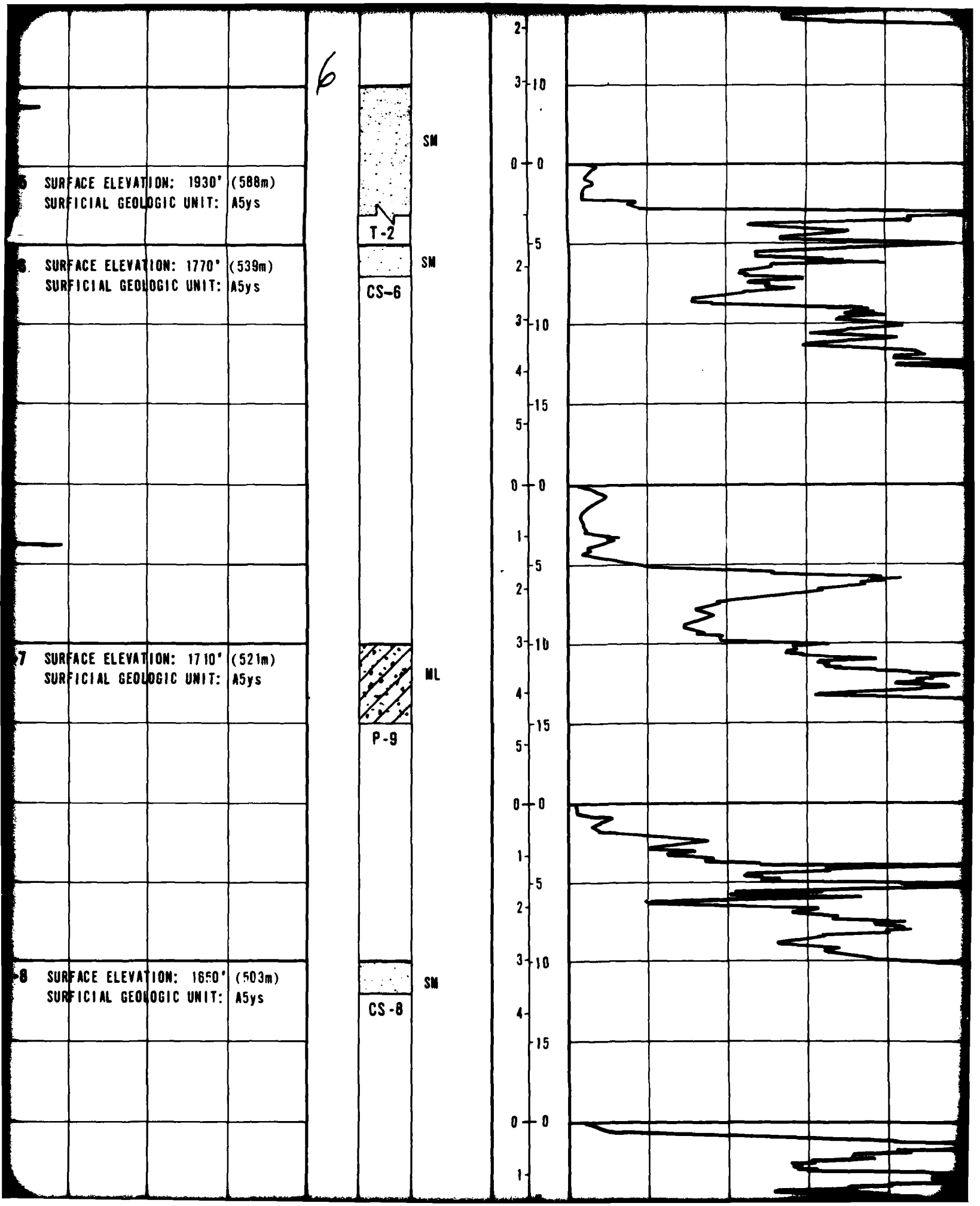
3

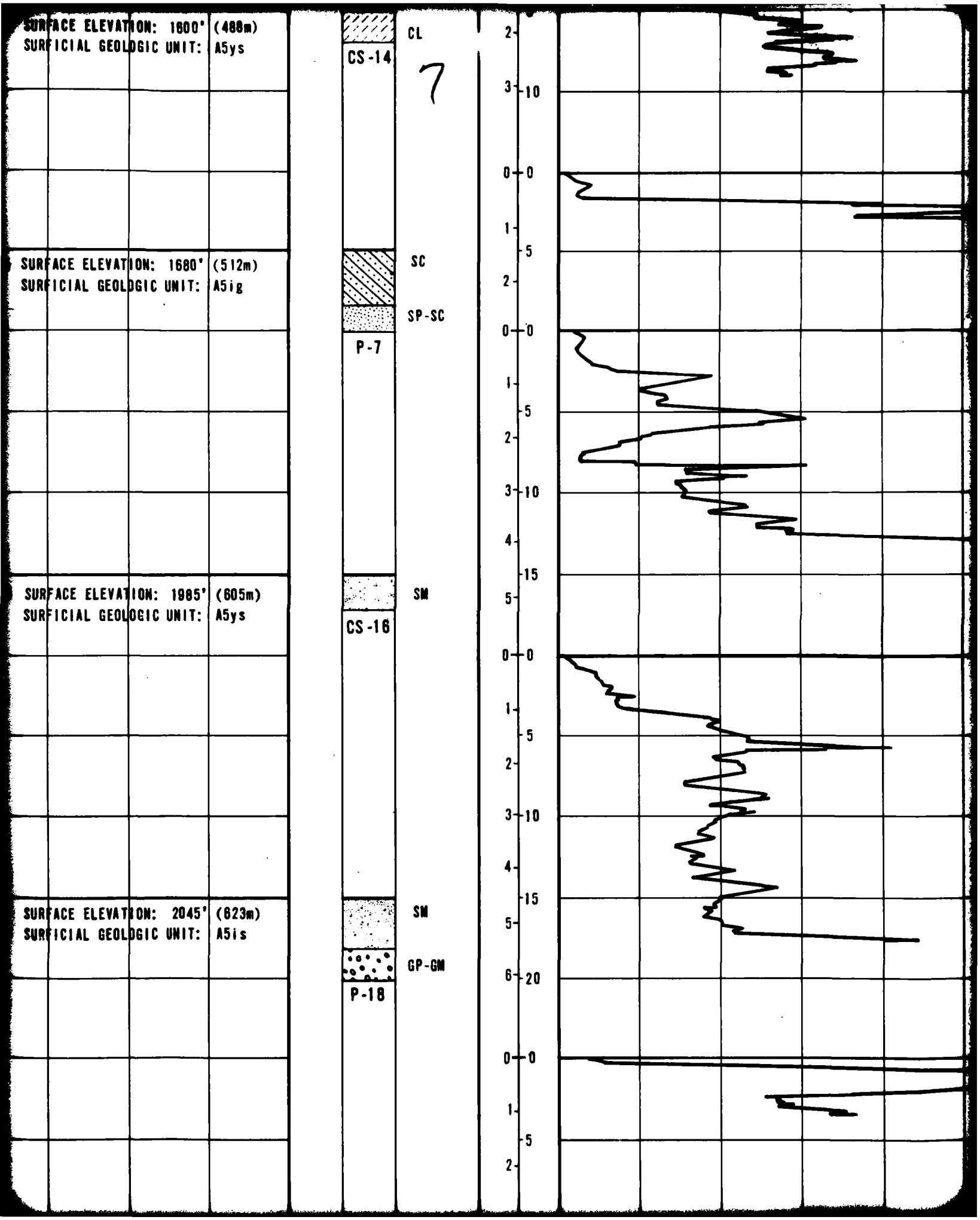

600 700 800 900 (kg/cm²)
600 700 800 900 (tsf)
SOIL COLUMN
C-12 SURFACE ELEVATION: 1530' (466m)
SURFICIAL GEOLOGIC UNIT: A5ys
SM
CS-12
C-13 SURFACE ELEVATION: 1560' (475m)
SURFICIAL GEOLOGIC UNIT: A5is
SC
SM
P-6
C-14 SURFACE ELEVATION: 1600' (488m)
SURFICIAL GEOLOGIC UNIT: A5ys
CL
CS-14
DEPTH
(METERS)
(FEET)
0 100 200 300
0 100 200 300
0 1 2 0 1 2 3 0 1 2 3 0 1 2 3 0
0 5 0 5 10 0 5 10 0 5 10 0

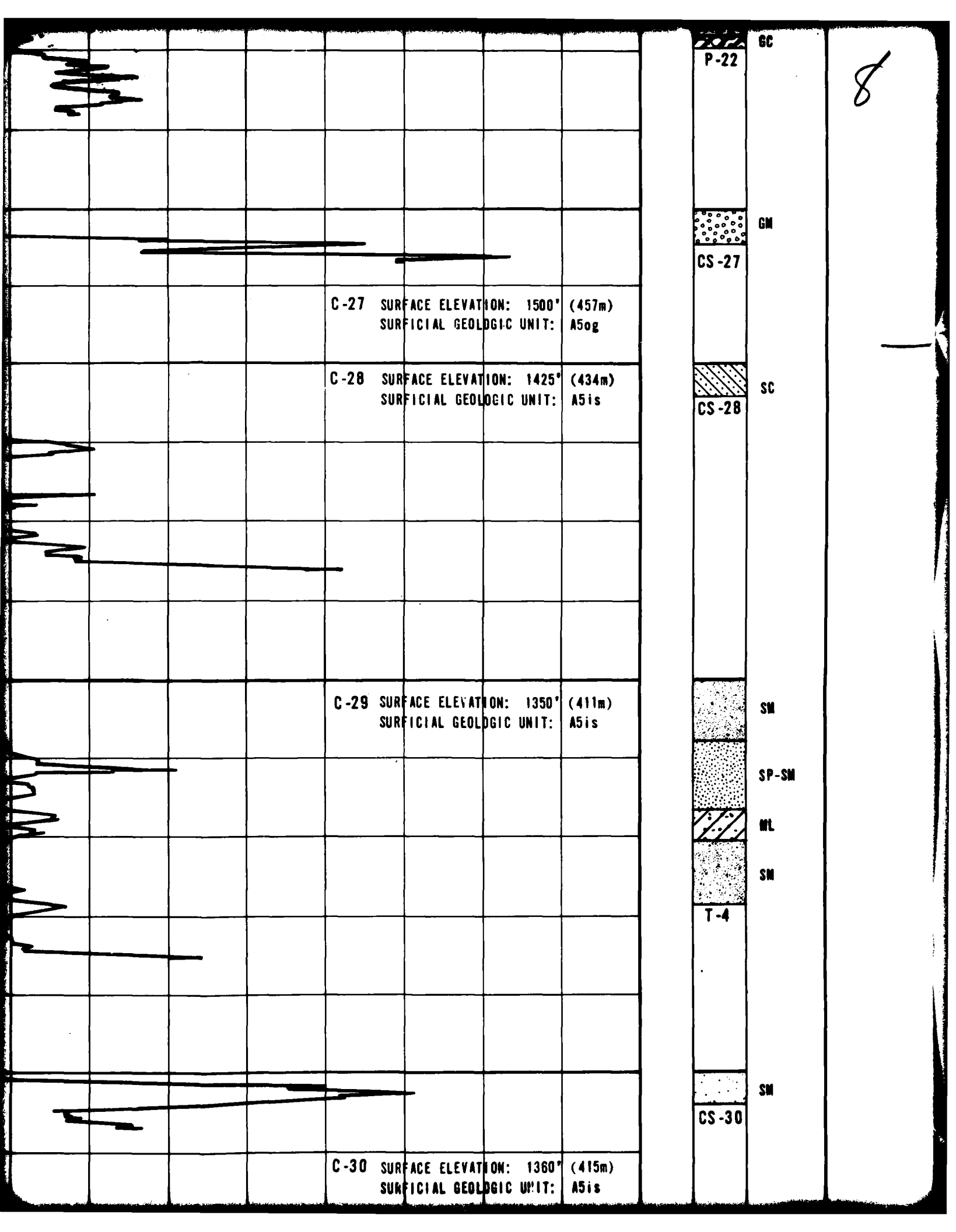
CONE RESISTANCE



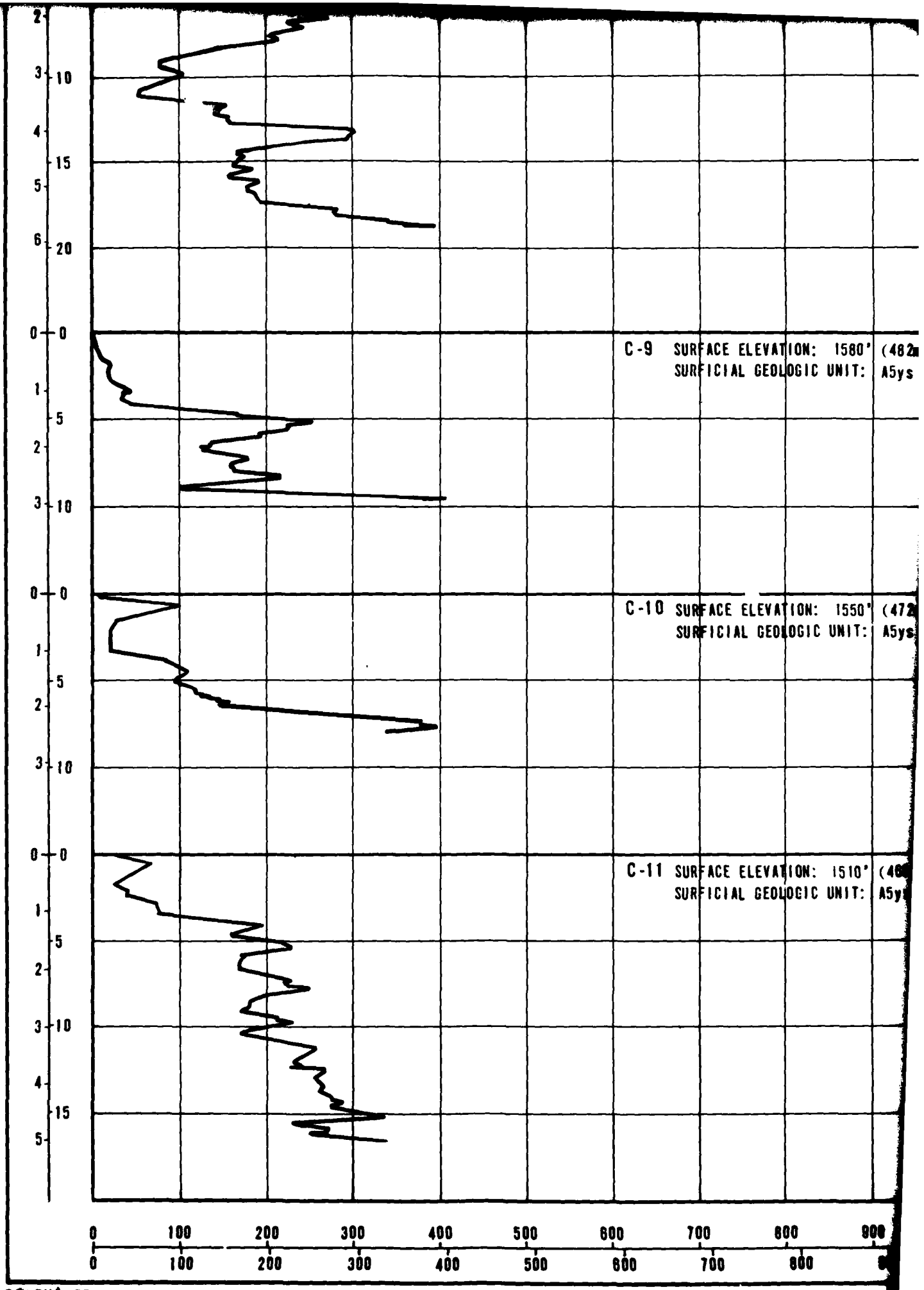

C-5 SURFACE ELEVATION: 1930' (588m)
SURFICIAL GEOLOGIC UNIT: A5ys
C-6 SURFACE ELEVATION: 1770' (539m)
SURFICIAL GEOLOGIC UNIT: A5ys
C-7 SURFACE ELEVATION: 1710' (521m)
SURFICIAL GEOLOGIC UNIT: A5ys
C-8 SURFACE ELEVATION: 1650' (503m)
SURFICIAL GEOLOGIC UNIT: A5ys


6
SURFACE ELEVATION: 1930' (588m)
SURFICIAL GEOLOGIC UNIT: A5ys
SURFACE ELEVATION: 1770' (539m)
SURFICIAL GEOLOGIC UNIT: A5ys
SURFACE ELEVATION: 1710' (521m)
SURFICIAL GEOLOGIC UNIT: A5ys
SURFACE ELEVATION: 1650' (503m)
SURFICIAL GEOLOGIC UNIT: A5ys
T-2
CS-6
P-9
CS-8
SM
SM
ML
SM
2
3 10
0 0
5
2
3 10
4
15
5
0 0
1
5
2
3 10
4
15
5
0 0
1
5
2
3 10
4
15
0 0
1

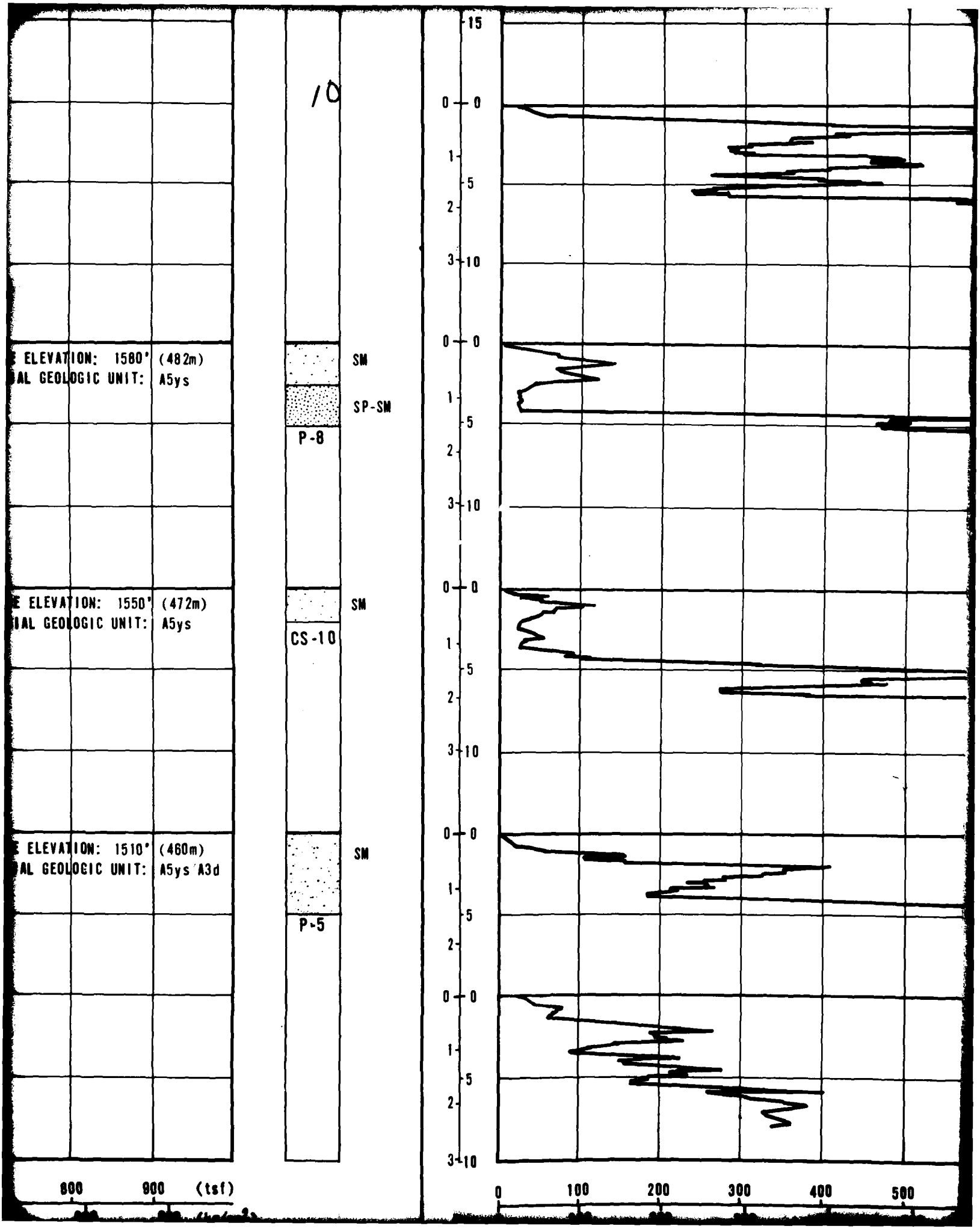

SURFACE ELEVATION: 1600' (488m)
SURFICIAL GEOLOGIC UNIT: A5ys
CS-14
CL
7
SURFACE ELEVATION: 1680' (512m)
SURFICIAL GEOLOGIC UNIT: A5ig
SC
SP-SC
P-7
SURFACE ELEVATION: 1985' (605m)
SURFICIAL GEOLOGIC UNIT: A5ys
SM
CS-16
SURFACE ELEVATION: 2045' (623m)
SURFICIAL GEOLOGIC UNIT: A5is
SM
GP-GM
P-18
2
3 10
0 0
1 5
2
0 0
1 5
2 10
3 15
4
5 0
1 5
2 10
3 15
4
5 20
6 0
1 5
2

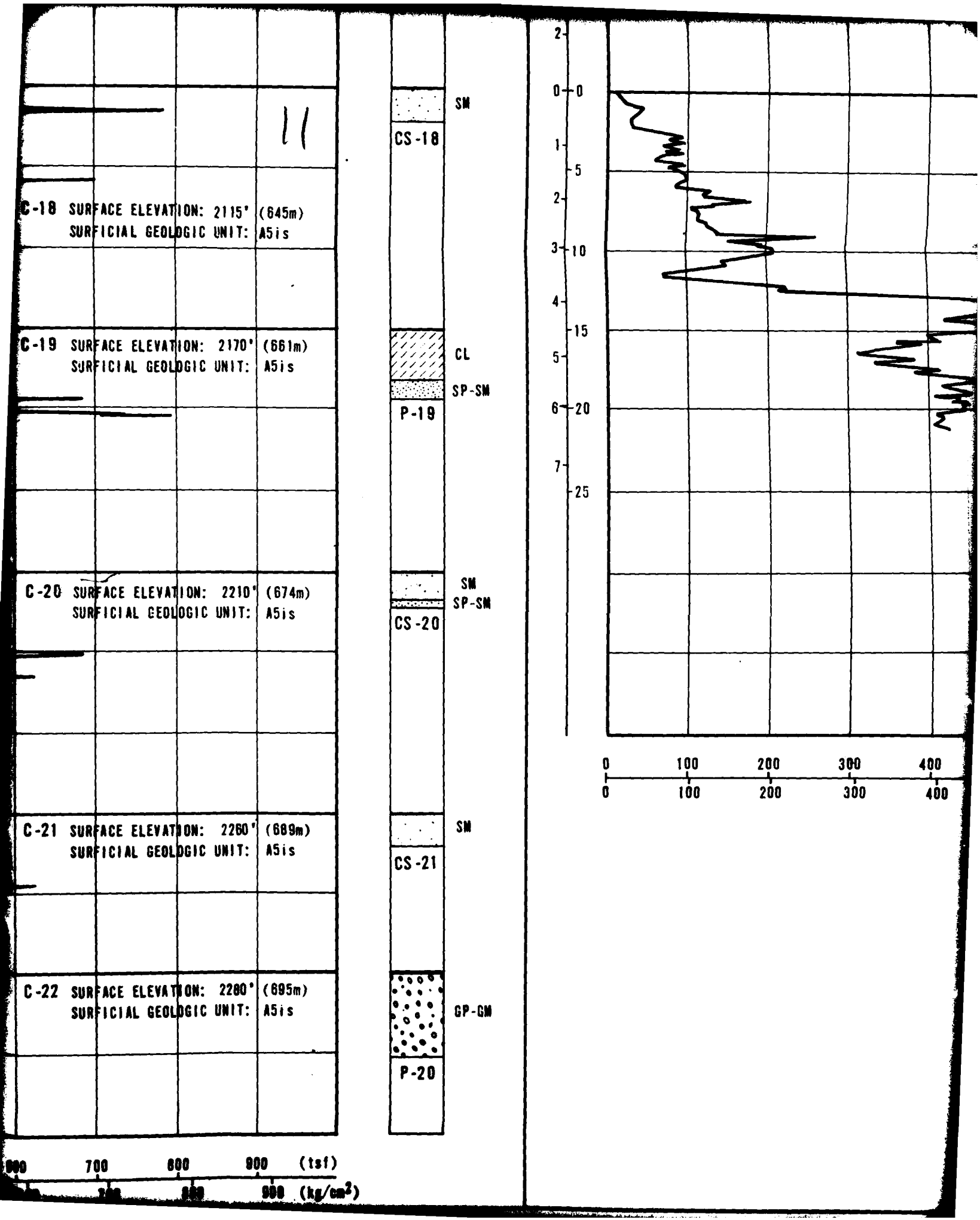

P-22
GC
GM
CS-27
C-27 SURFACE ELEVATION: 1500' (457m)
SURFICIAL GEOLOGIC UNIT: A5og
C-28 SURFACE ELEVATION: 1425' (434m)
SURFICIAL GEOLOGIC UNIT: A5is
SC
CS-28
C-29 SURFACE ELEVATION: 1350' (411m)
SURFICIAL GEOLOGIC UNIT: A5is
SM
SP-SM
ML
SM
T-4
SM
CS-30
C-30 SURFACE ELEVATION: 1360' (415m)
SURFICIAL GEOLOGIC UNIT: A5is

9



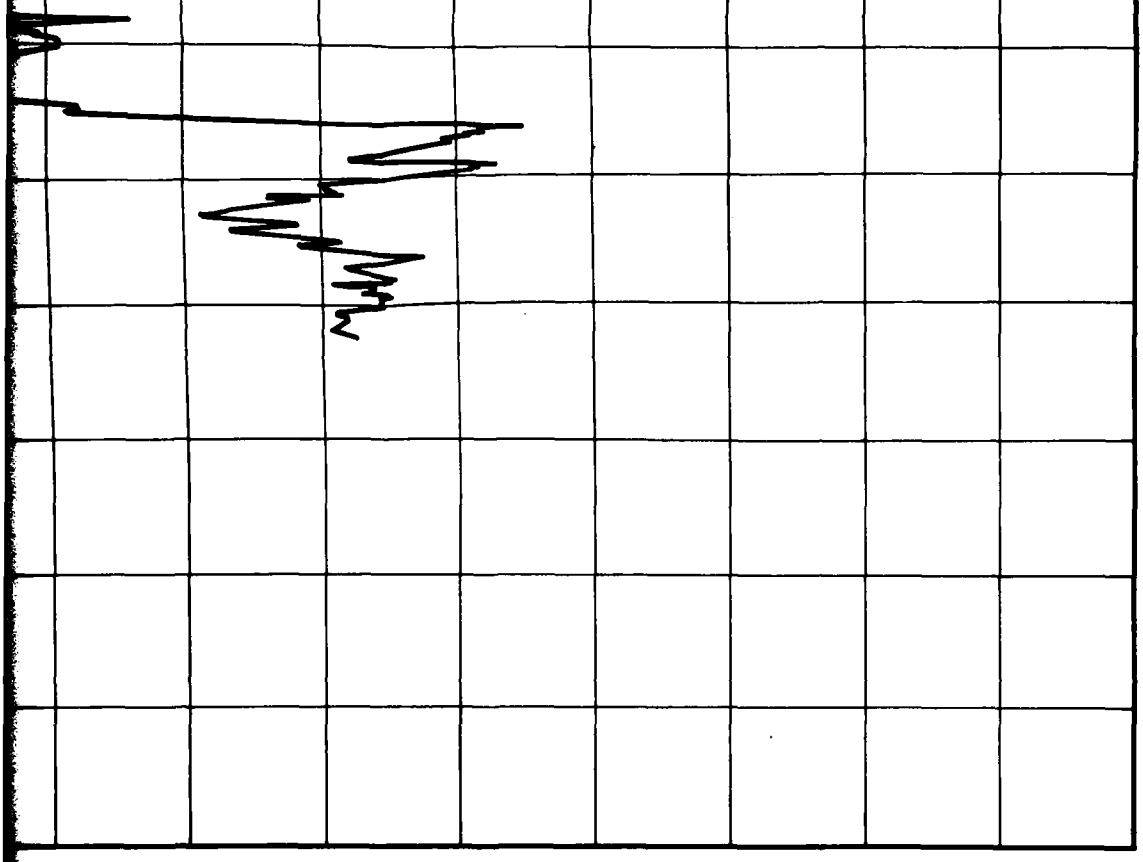
CHECKED BY _____ APPROVED BY _____

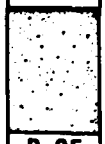

10
E ELEVATION: 1580' (482m)
AL GEOLOGIC UNIT: A5ys
SM
SP-SM
P-8
E ELEVATION: 1550' (472m)
IAL GEOLOGIC UNIT: A5ys
SM
CS-10
E ELEVATION: 1510' (460m)
AL GEOLOGIC UNIT: A5ys A3d
SM
P-5
800
900
(tsf)
15
0
0
1
5
2
3
10
0
0
1
5
2
3
10
0
0
1
5
2
3
10
0
0
1
5
2
0
0
1
5
2
3
10
0
100
200
300
400
500


11
C-18 SURFACE ELEVATION: 2115' (645m)
SURFICIAL GEOLOGIC UNIT: A5is
C-19 SURFACE ELEVATION: 2170' (661m)
SURFICIAL GEOLOGIC UNIT: A5is
C-20 SURFACE ELEVATION: 2210' (674m)
SURFICIAL GEOLOGIC UNIT: A5is
C-21 SURFACE ELEVATION: 2260' (689m)
SURFICIAL GEOLOGIC UNIT: A5is
C-22 SURFACE ELEVATION: 2280' (695m)
SURFICIAL GEOLOGIC UNIT: A5is
SM
CS-18
CL
SP-SM
P-19
SM
SP-SM
CS-20
SM
CS-21
GP-GM
P-20
2
0
1
2
3
4
5
6
7
0
5
10
15
20
25
0
100
200
300
400
0
100
200
300
400
600
700
800
900
(tsf)
(kg/cm²)

C-30 SURFACE ELEVATION: 1360' (415m)
SURFICIAL GEOLOGIC UNIT: A5is

C-31 SURFACE ELEVATION: 1240' (378m)
SURFICIAL GEOLOGIC UNIT A5o





SM

P-25

12

200 300 400 500 600 700 800 900 (tsf)

200 300 400 500 600 700 800 900 (kg/cm^2)

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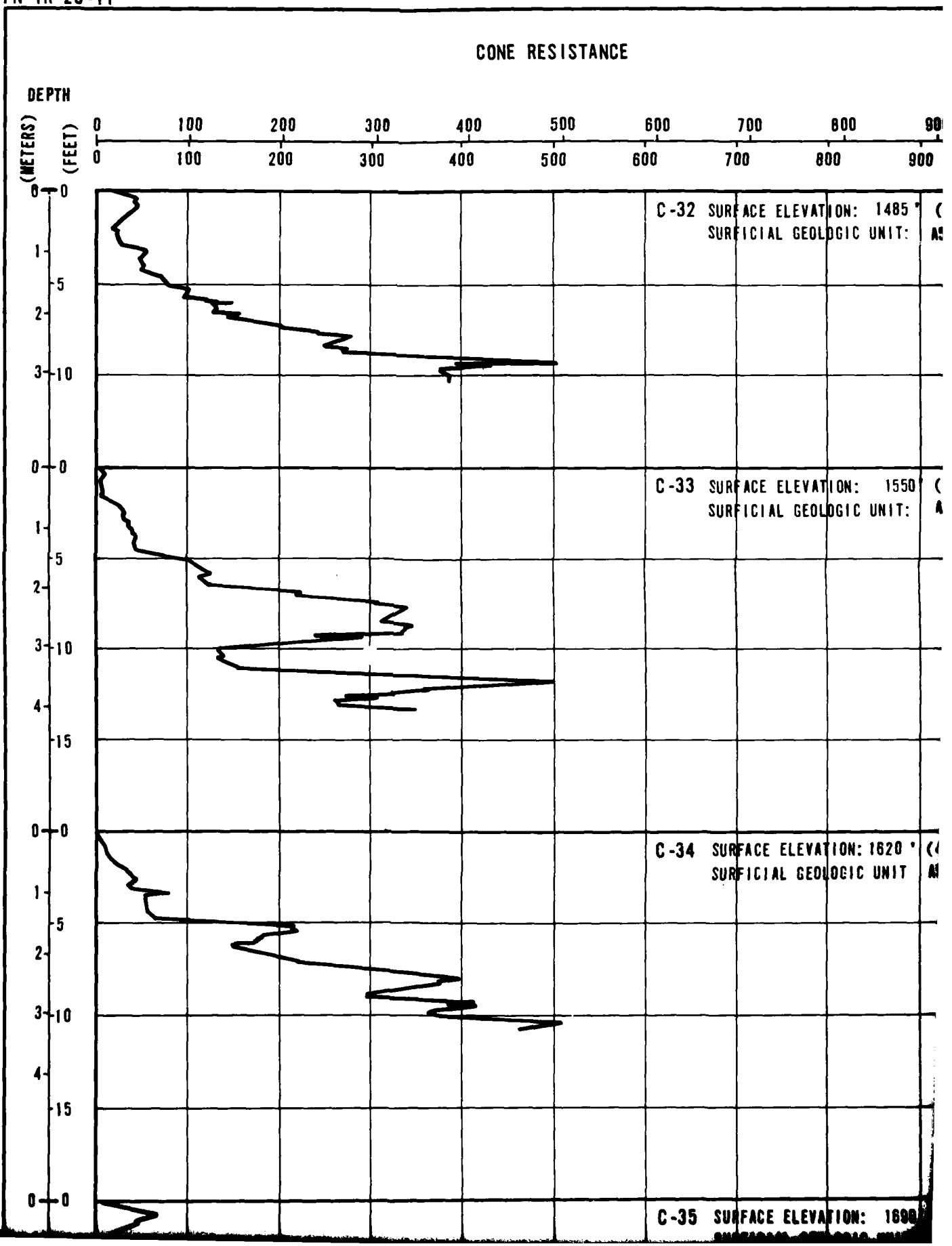
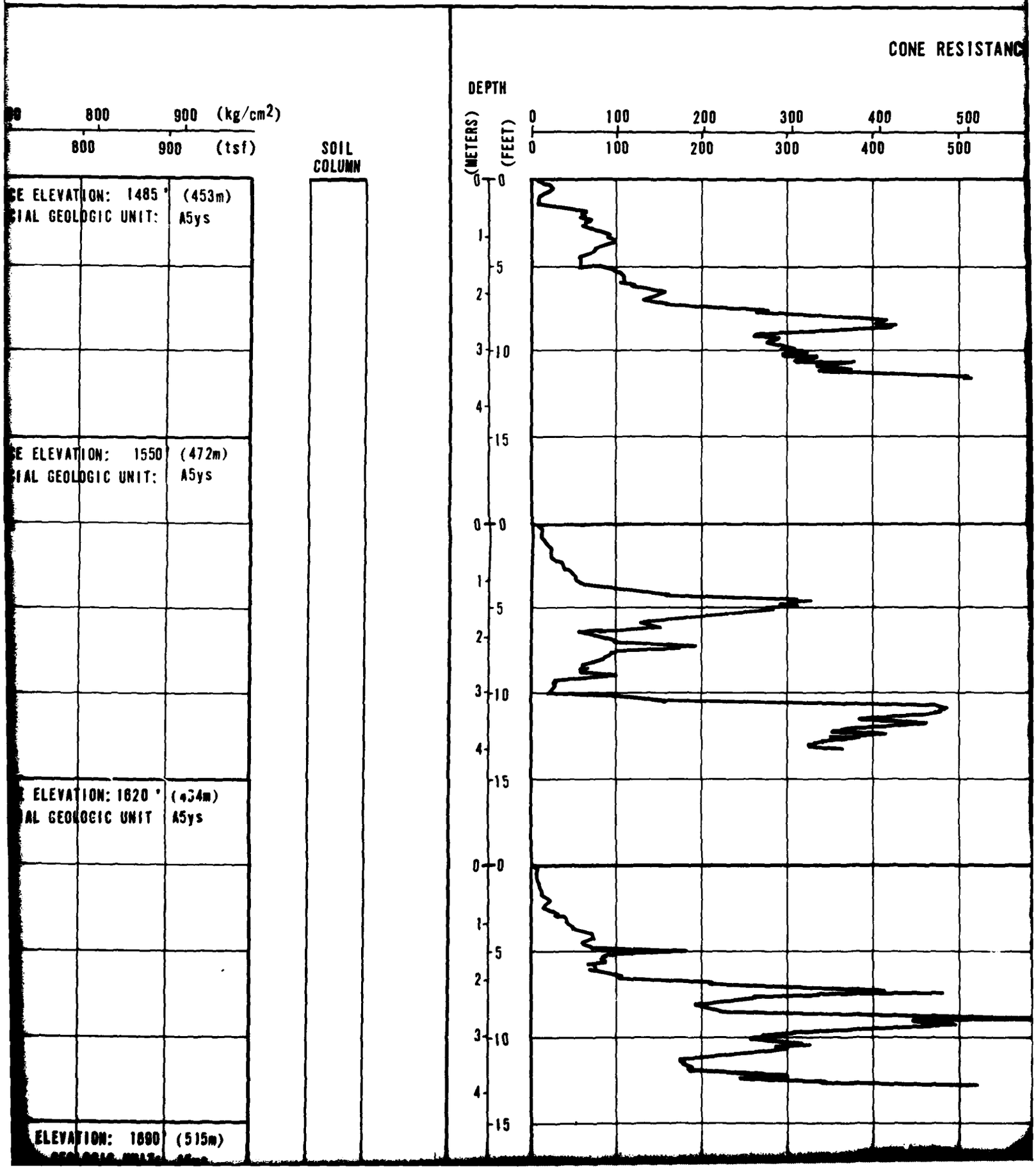
2
1 OF 3

FUGRO NATIONAL, INC.

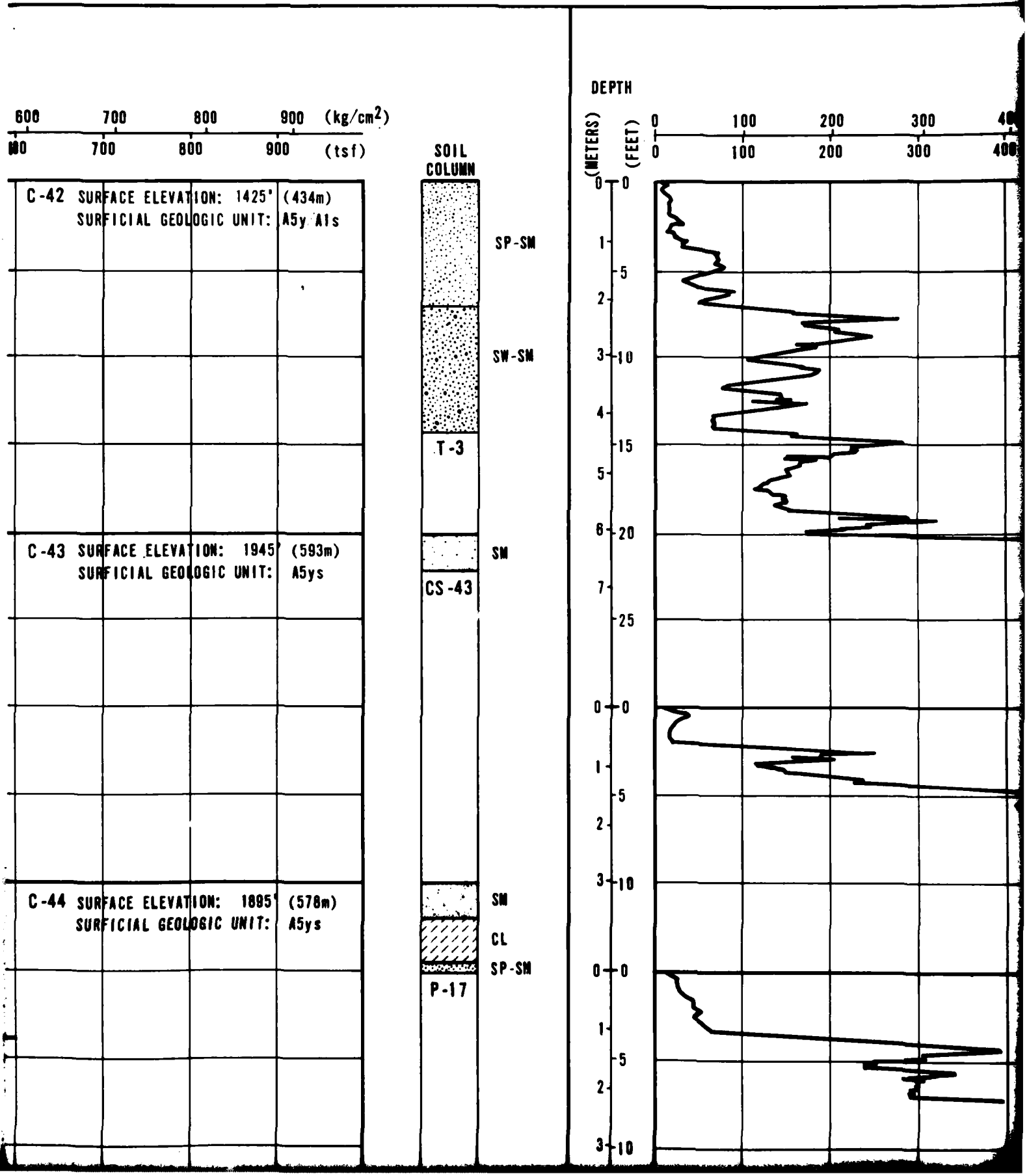
FN-TR-28-11


CONE RESISTANCE
DEPTH
(METERS)
(FEET)
0 100 200 300 400 500 600 700 800 900
C-32 SURFACE ELEVATION: 1485 '
SURFICIAL GEOLOGIC UNIT:
C-33 SURFACE ELEVATION: 1550 '
SURFICIAL GEOLOGIC UNIT:
C-34 SURFACE ELEVATION: 1620 '
SURFICIAL GEOLOGIC UNIT
C-35 SURFACE ELEVATION:

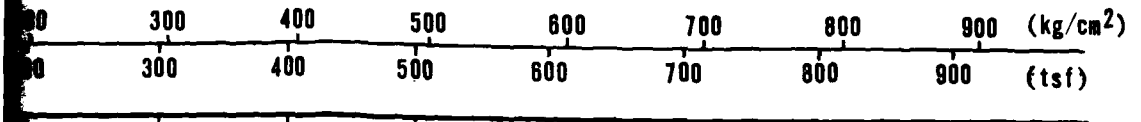
2


CONE RESISTANC
DEPTH
(METERS)
(FEET)
0 100 200 300 400 500
0 100 200 300 400 500
800 900 (kg/cm2)
800 900 (tsf)
SOIL COLUMN
E ELEVATION: 1485 ' (453m)
IAL GEOLOGIC UNIT: A5ys
E ELEVATION: 1550 ' (472m)
IAL GEOLOGIC UNIT: A5ys
ELEVATION: 1620 ' (494m)
AL GEOLOGIC UNIT A5ys
ELEVATION: 1890 (515m)

3


600 700 800 900 (kg/cm²)
600 700 800 900 (tsf)
C-42 SURFACE ELEVATION: 1425' (434m)
SURFICIAL GEOLOGIC UNIT: A5y A1s
C-43 SURFACE ELEVATION: 1945' (593m)
SURFICIAL GEOLOGIC UNIT: A5ys
C-44 SURFACE ELEVATION: 1895' (578m)
SURFICIAL GEOLOGIC UNIT: A5ys
SOIL COLUMN
SP-SM
SW-SM
T-3
SM
CS-43
SM
CL
SP-SM
P-17
DEPTH
(METERS)
(FEET)
0 100 200 300
0 100 200 300
0 1 2 3 4 5 6 7 0 1 2 3 0 1 2 3
0 5 10 15 20 25 0 5 10 0 5 10

CONE RESISTANCE

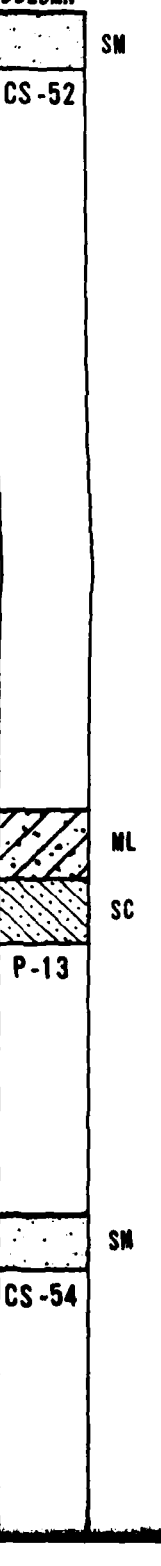


C-52 SURFACE ELEVATION: 1820' (555m)
SURFICIAL GEOLOGIC UNIT: A5ys

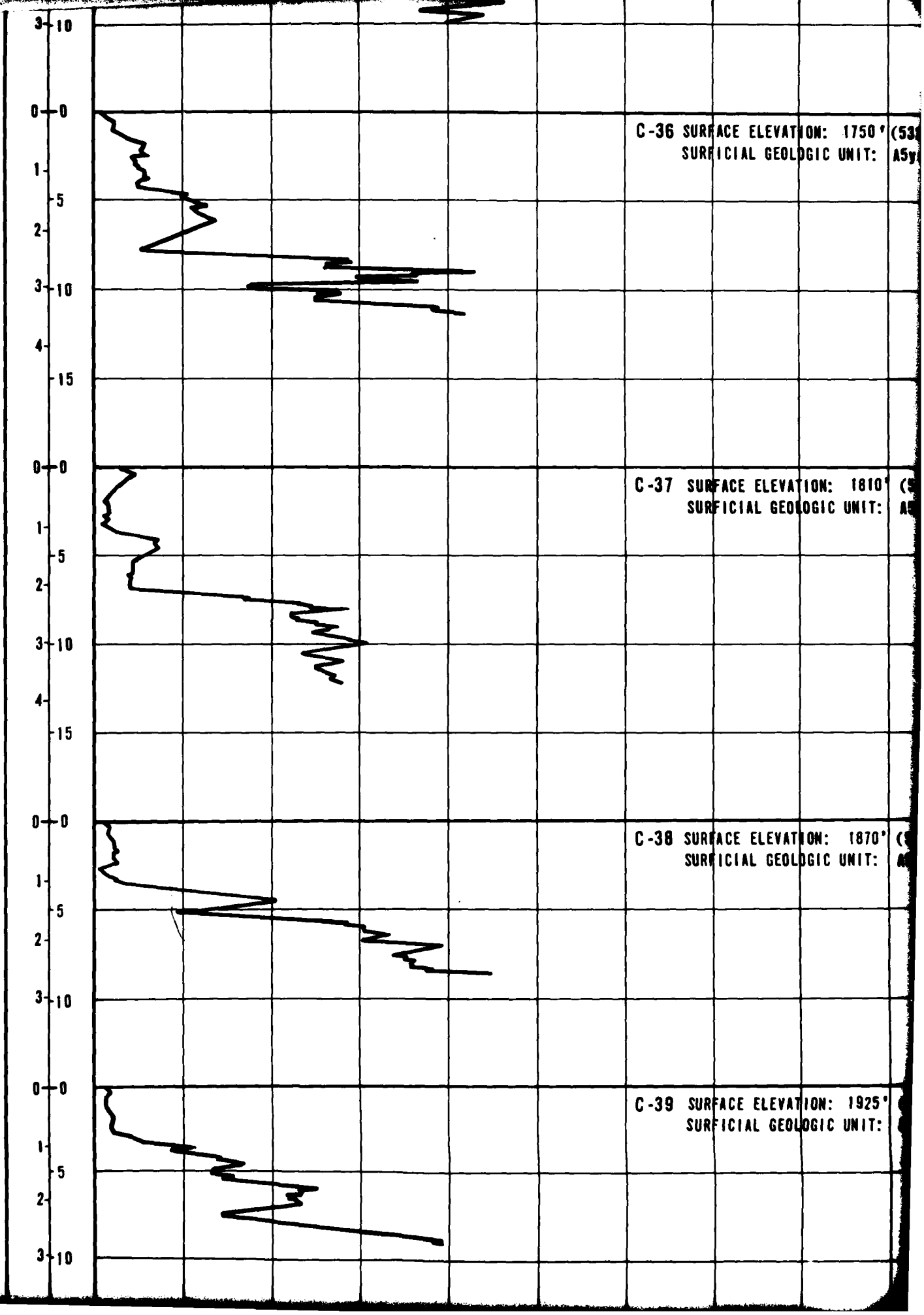
C-53 SURFACE ELEVATION: 1840' (561m)
SURFICIAL GEOLOGIC UNIT: A5ys

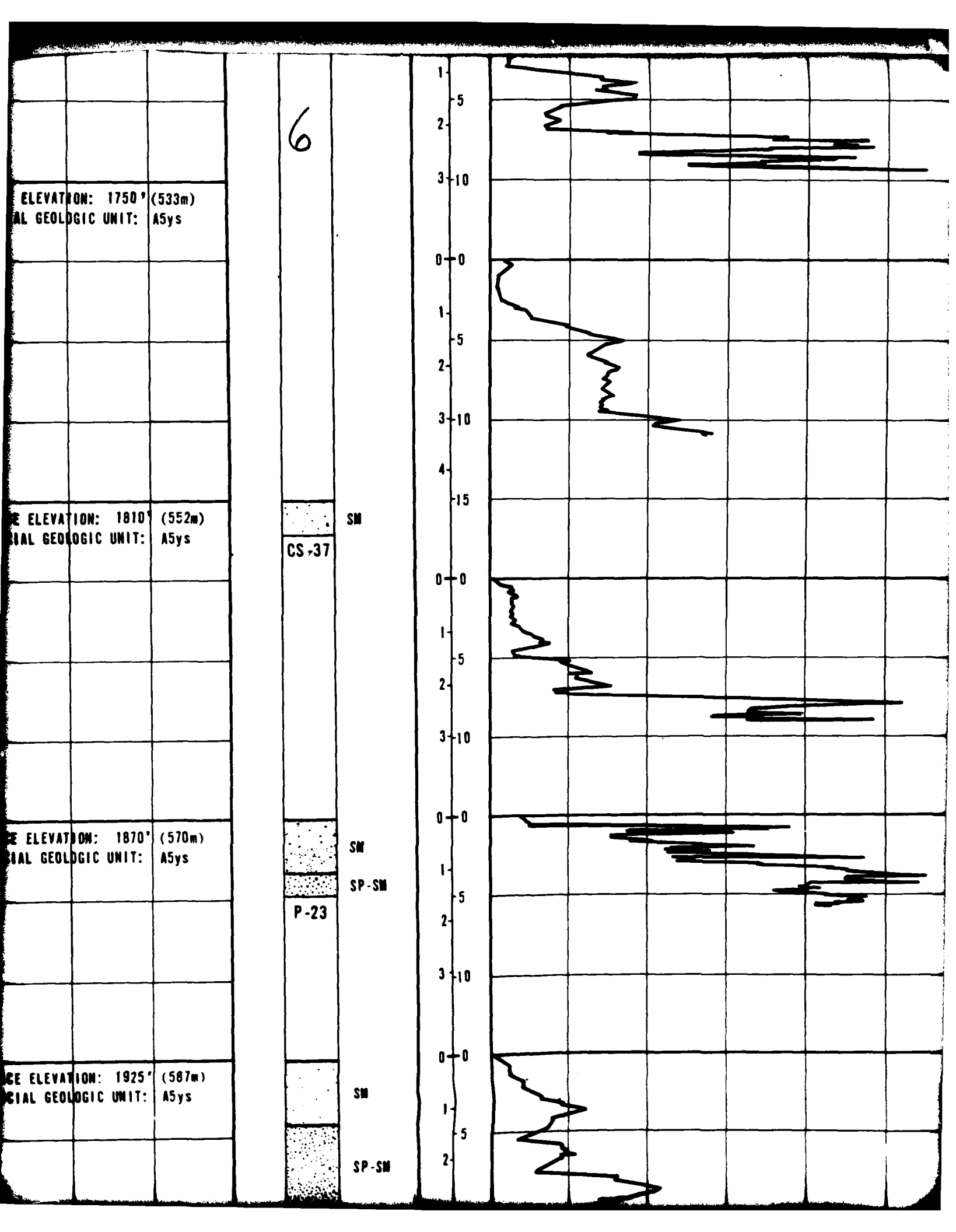
C-54 SURFACE ELEVATION: 1880' (573m)
SURFICIAL GEOLOGIC UNIT: A5ys

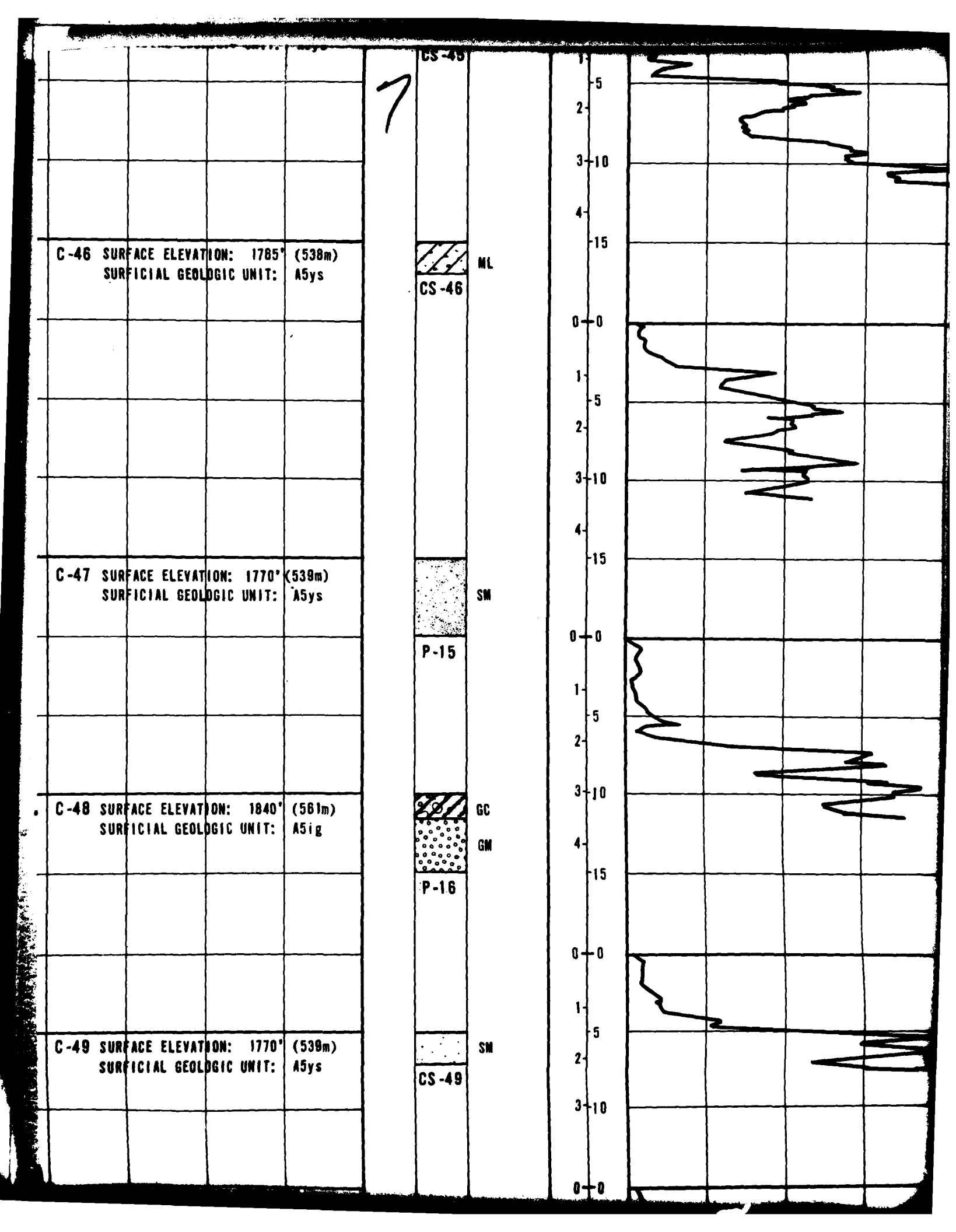
SOIL COLUMN



5


C-36 SURFACE ELEVATION: 1750' (53
SURFICIAL GEOLOGIC UNIT: A5y
C-37 SURFACE ELEVATION: 1810' (5
SURFICIAL GEOLOGIC UNIT: A
C-38 SURFACE ELEVATION: 1870' (
SURFICIAL GEOLOGIC UNIT: A
C-39 SURFACE ELEVATION: 1925'
SURFICIAL GEOLOGIC UNIT:


6
ELEVATION: 1750' (533m)
AL GEOLOGIC UNIT: A5ys
E ELEVATION: 1810' (552m)
IAL GEOLOGIC UNIT: A5ys
CS-37
SM
E ELEVATION: 1870' (570m)
IAL GEOLOGIC UNIT: A5ys
SM
SP-SM
P-23
E ELEVATION: 1925' (587m)
IAL GEOLOGIC UNIT: A5ys
SM
SP-SM
1 5 2 3 10 0 0 1 5 2 3 10 4 15 0 0 1 5 2 3 10 0 0 1 5 2 3 10 0 0 1 5 2


CS-45
C-46 SURFACE ELEVATION: 1785' (538m)
SURFICIAL GEOLOGIC UNIT: A5ys
ML
CS-46
C-47 SURFACE ELEVATION: 1770' (539m)
SURFICIAL GEOLOGIC UNIT: A5ys
SM
P-15
C-48 SURFACE ELEVATION: 1840' (561m)
SURFICIAL GEOLOGIC UNIT: A5ig
GC
GM
P-16
C-49 SURFACE ELEVATION: 1770' (539m)
SURFICIAL GEOLOGIC UNIT: A5ys
SM
CS-49

SURFICIAL GEOLOGIC UNIT: A5ys

SM

GM

P-10

8

C-56 SURFACE ELEVATION: 1510' (460m)
SURFICIAL GEOLOGIC UNIT: A5ys

CL

CS-56

C-57 SURFACE ELEVATION: 1470' (448m)
SURFICIAL GEOLOGIC UNIT: A5ys

SM

CS-57

C-58 SURFACE ELEVATION: 1455' (443m)
SURFICIAL GEOLOGIC UNIT: A5ys

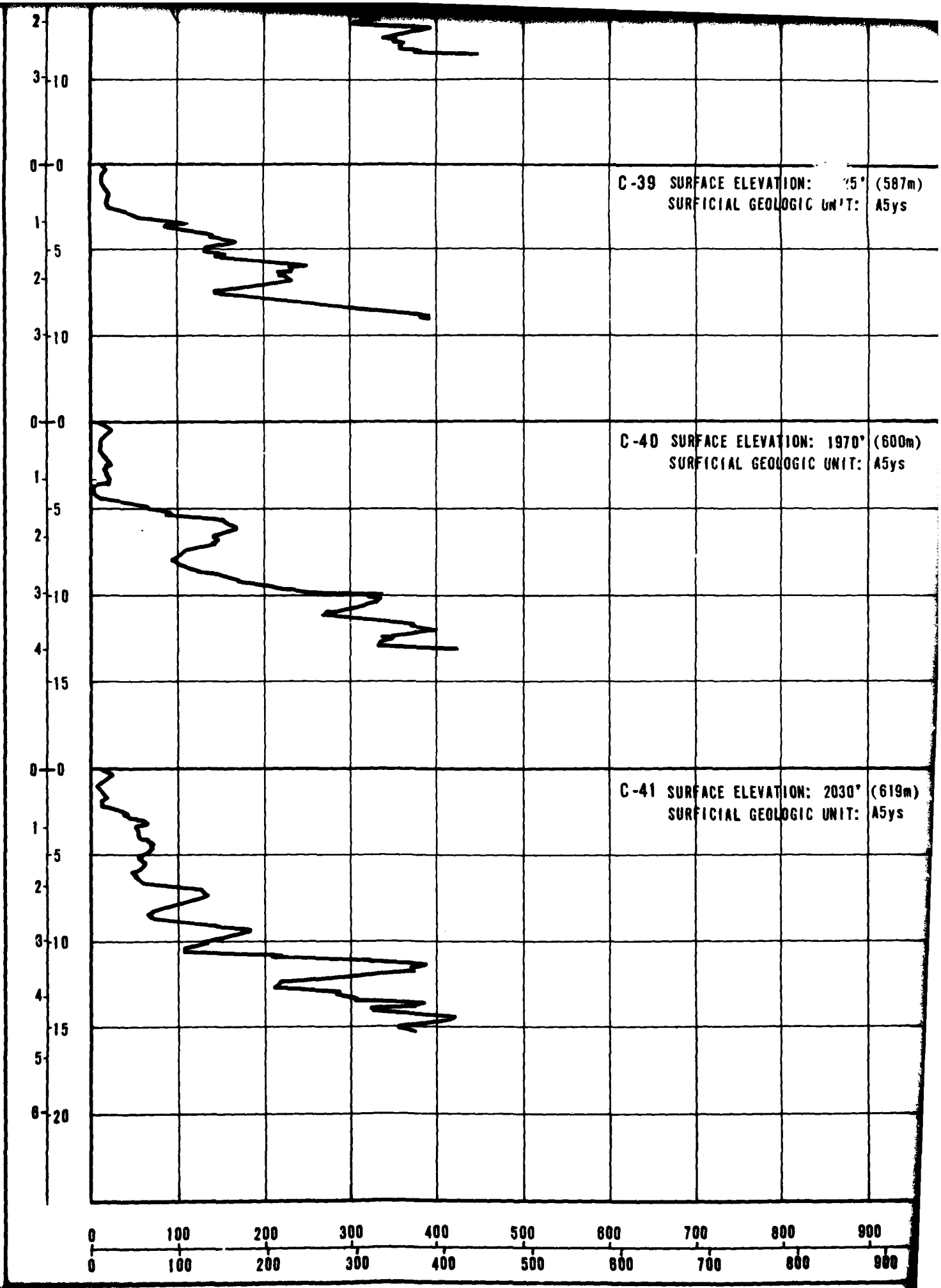
CL

SM

SP-SM

P-4

9



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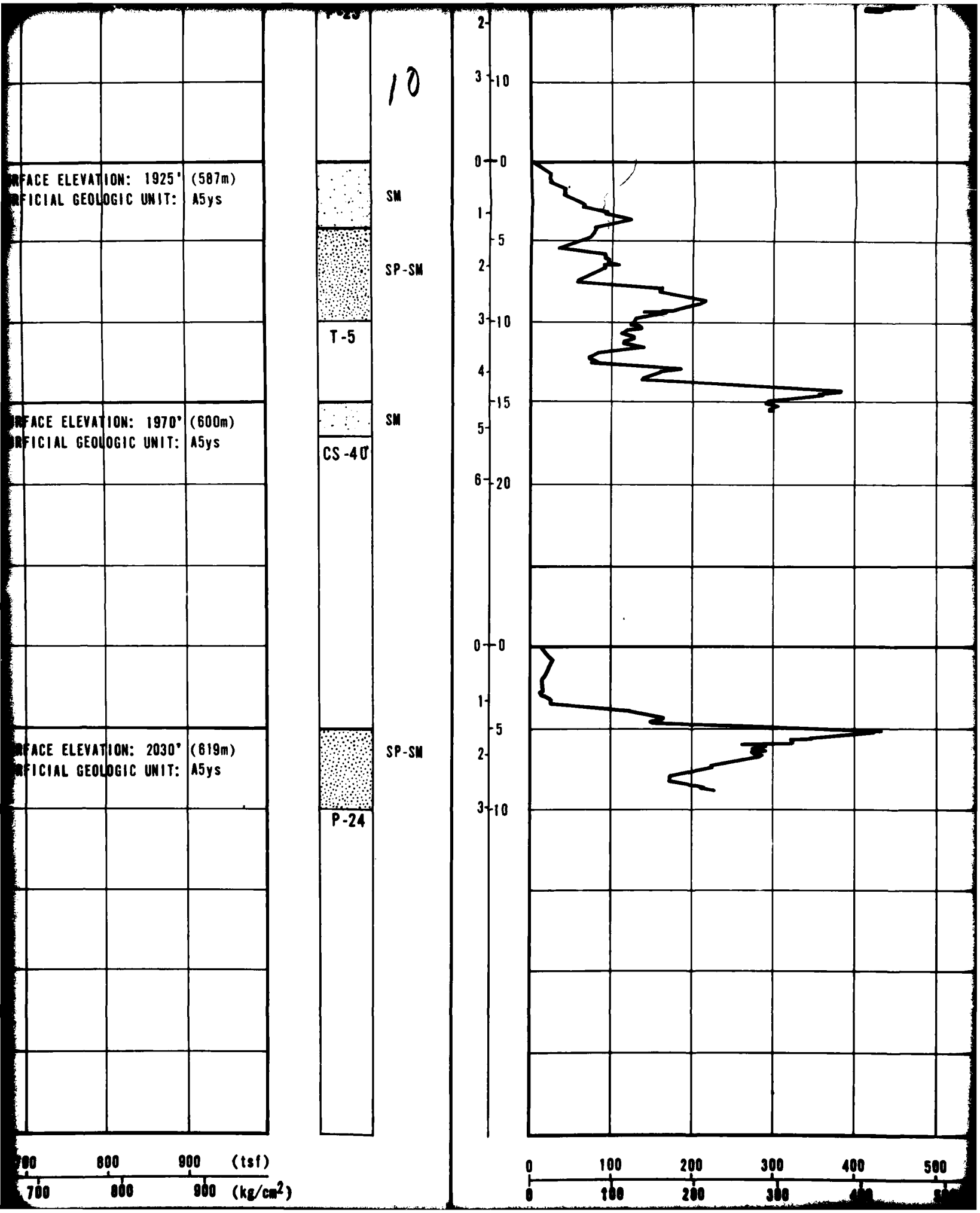
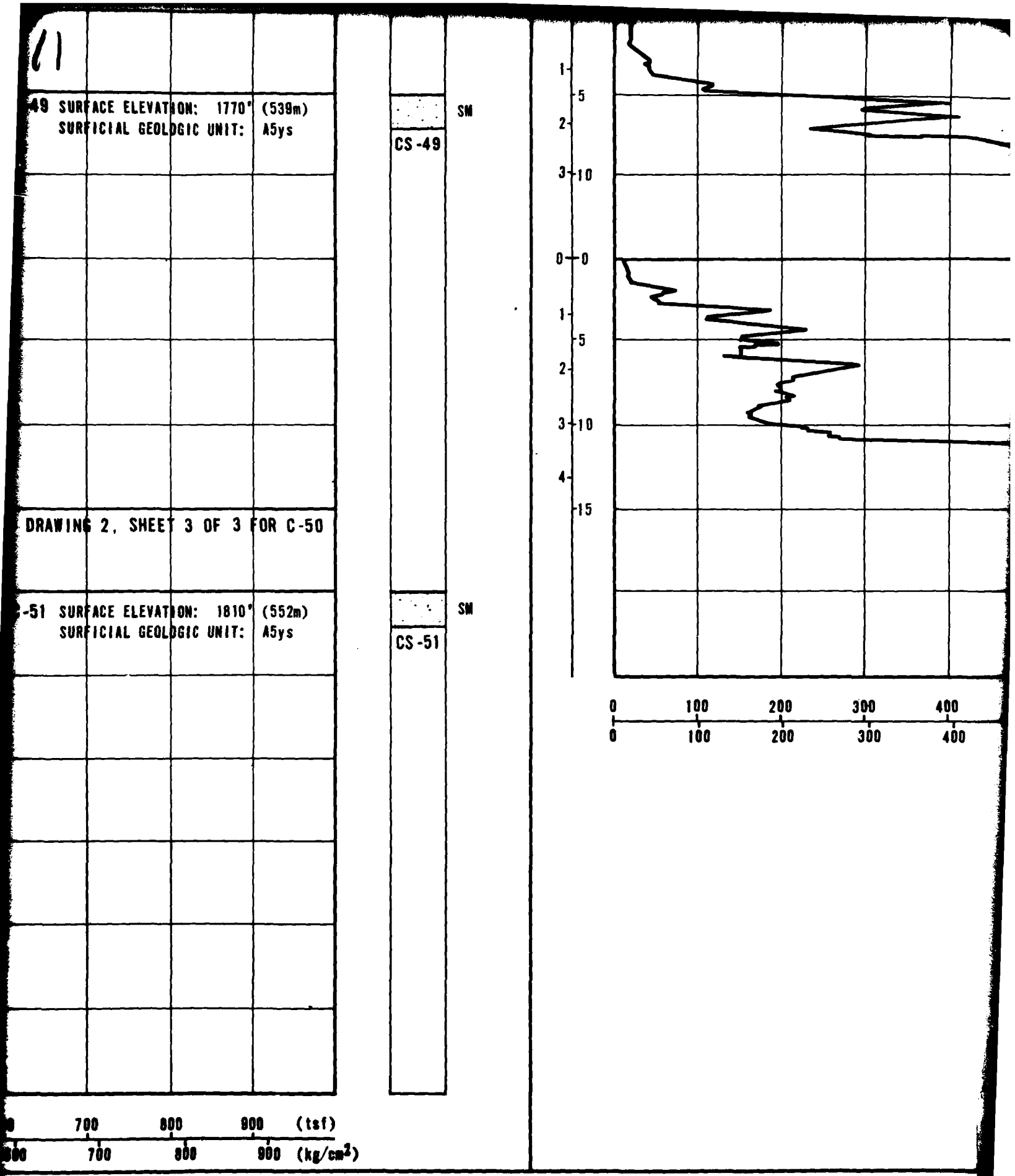
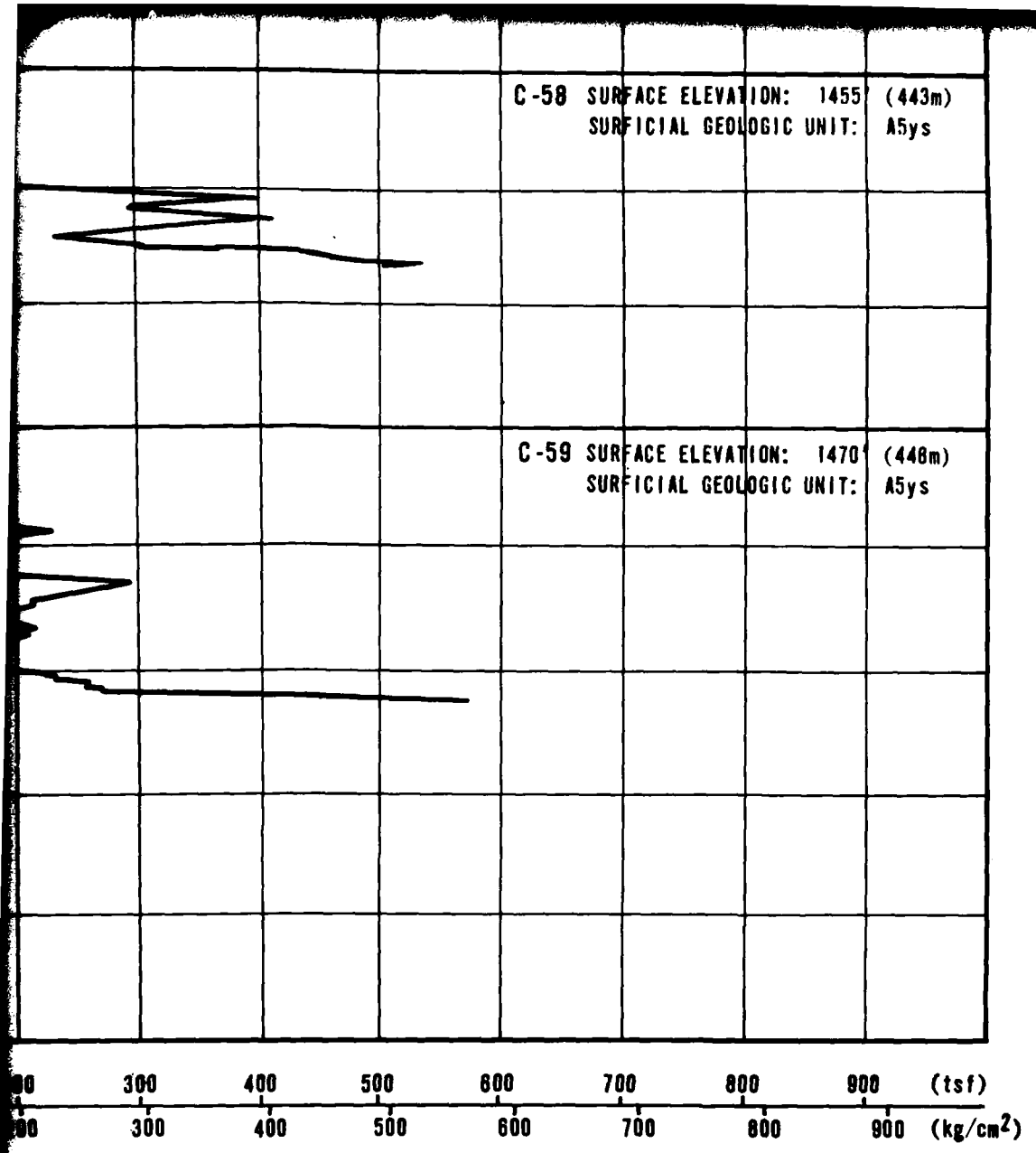

10
RFACE ELEVATION: 1925' (587m)
RFICIAL GEOLOGIC UNIT: A5ys
SM
SP-SM
T-5
RFACE ELEVATION: 1970' (600m)
RFICIAL GEOLOGIC UNIT: A5ys
SM
CS-40
RFACE ELEVATION: 2030' (619m)
RFICIAL GEOLOGIC UNIT: A5ys
SP-SM
P-24
2
3 10
0 0
1 5
2 10
3 15
4 20
5
6
0 0
1 5
2 10
3
700 800 900 (tsf)
700 800 900 (kg/cm²)
0 100 200 300 400 500
0 100 200 300


-49 SURFACE ELEVATION: 1770' (539m)
SURFICIAL GEOLOGIC UNIT: A5ys
SM
CS-49
DRAWING 2, SHEET 3 OF 3 FOR C-50
-51 SURFACE ELEVATION: 1810' (552m)
SURFICIAL GEOLOGIC UNIT: A5ys
SM
CS-51
1
5
2
3
10
0
0
1
5
2
3
10
4
15
0
100
200
300
400
0
100
200
300
400
700
800
900
(tsf)
700
800
900
(kg/cm²)



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2
2 OF 3

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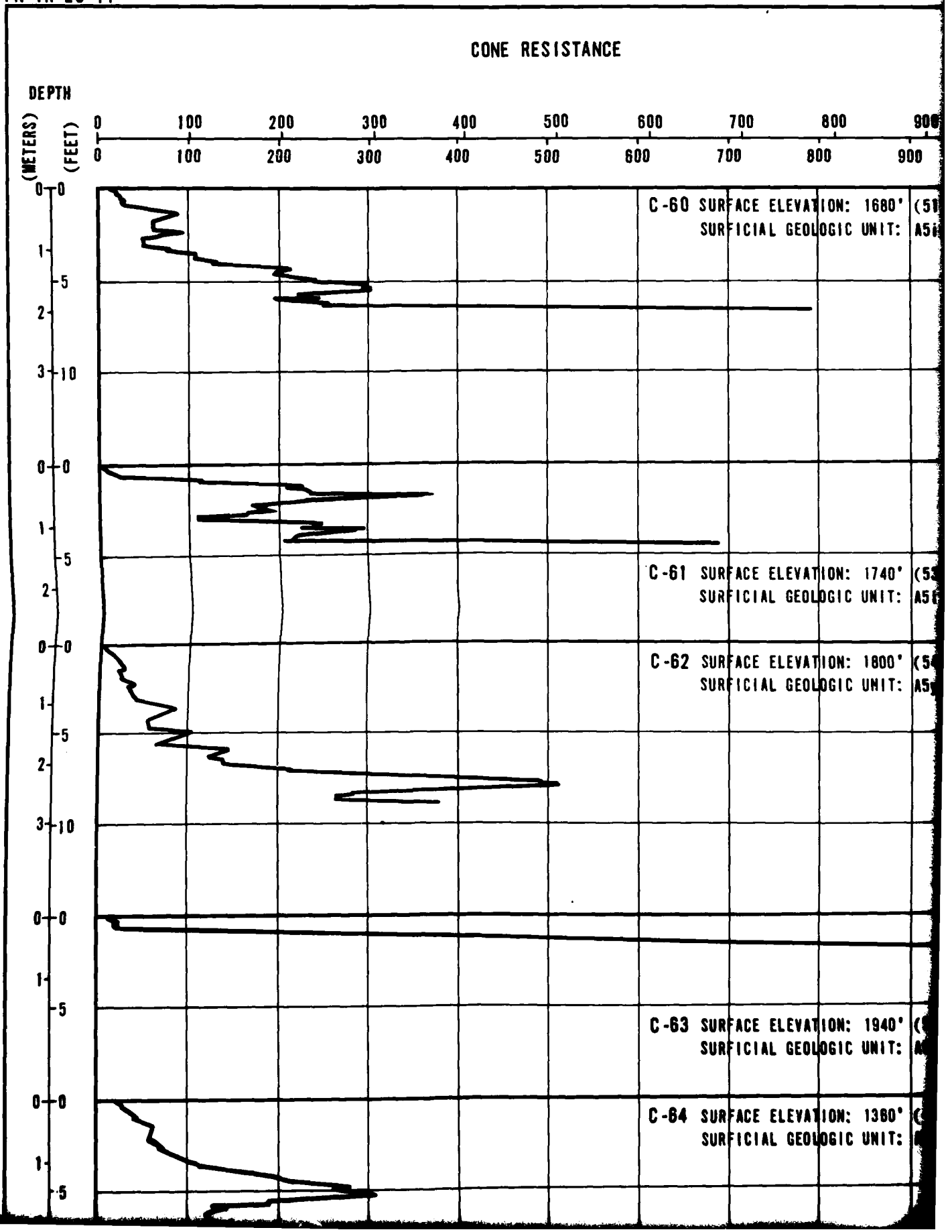

CONE RESISTANCE
DEPTH
(METERS)
(FEET)
0
100
200
300
400
500
600
700
800
900
C-60 SURFACE ELEVATION: 1680' (51
SURFICIAL GEOLOGIC UNIT: A5
C-61 SURFACE ELEVATION: 1740' (5
SURFICIAL GEOLOGIC UNIT: A5
C-62 SURFACE ELEVATION: 1800' (5
SURFICIAL GEOLOGIC UNIT: A5
C-63 SURFACE ELEVATION: 1940' (
SURFICIAL GEOLOGIC UNIT:
C-64 SURFACE ELEVATION: 1360' (
SURFICIAL GEOLOGIC UNIT:

2

CONE RESISTA

DEPTH

(METERS) (FEET)

0 100 200 300 400 500

0 100 200 300 400 500

800 900 (kg/cm²)

800 900 (tsf)

SOIL COLUMN

ACE ELEVATION: 1680' (512m)
CIAL GEOLOGIC UNIT: A5is

SM

P-2

SM

CS-62

ACE ELEVATION: 1740' (530m)
CIAL GEOLOGIC UNIT: A5is

ACE ELEVATION: 1800' (549m)
CIAL GEOLOGIC UNIT: A5ys

SM

SW-SM

P-3

SM

CS-63

CE ELEVATION: 1940' (591m)
CIAL GEOLOGIC UNIT: A5is

CE ELEVATION: 1360' (415m)
CIAL GEOLOGIC UNIT: A5ys

SM

CS-64

3

NCE

600 700 800 900 (kg/cm²)

600 700 800 900 (tsf)

SOIL COLUMN

FRICTION RESISTANCE

DEPTH

(METERS) (FEET)

10 8 6 4

8 6 4

0 0

1 5

2

3 10

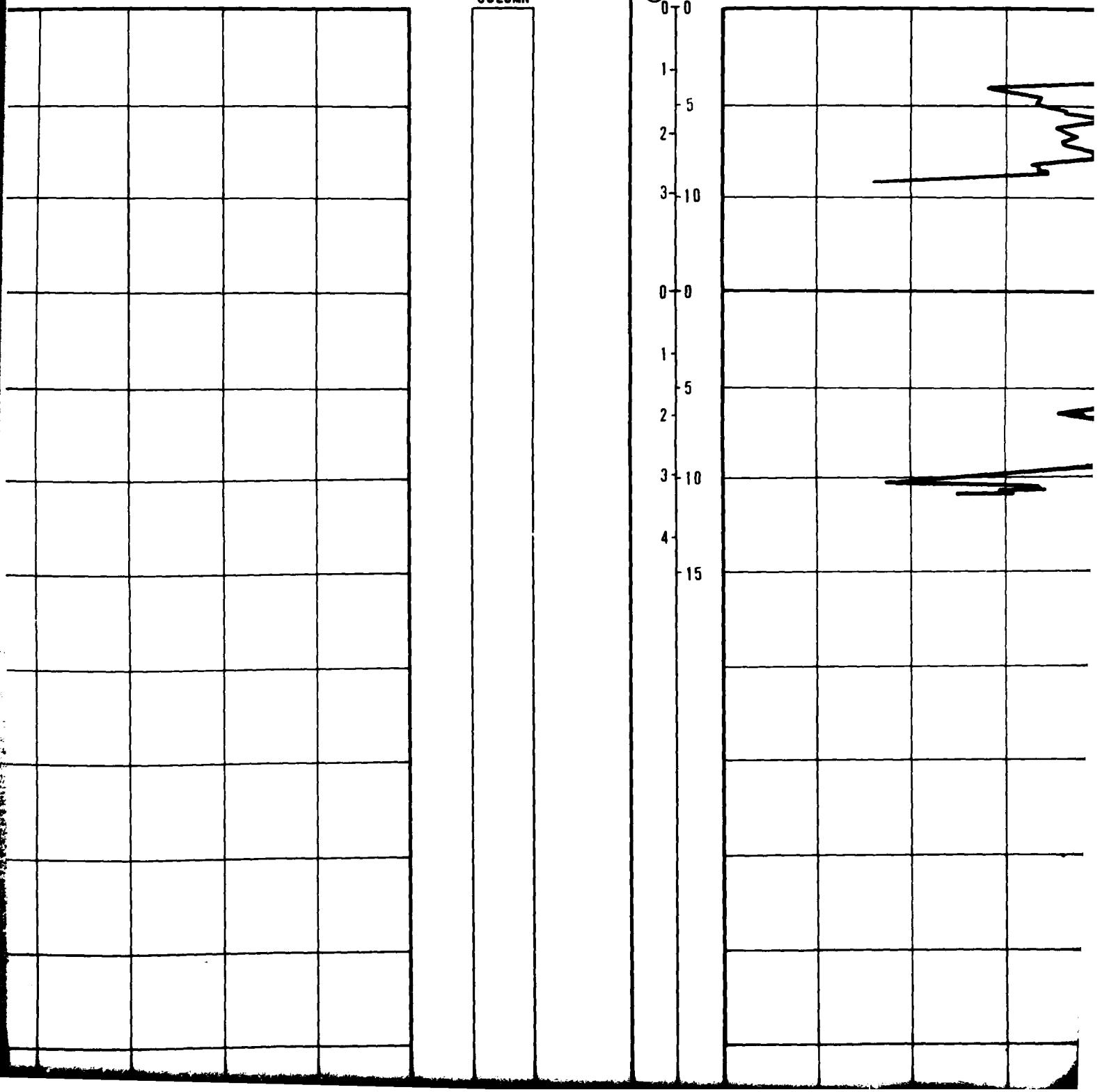
0 0

1 5

2

3 10

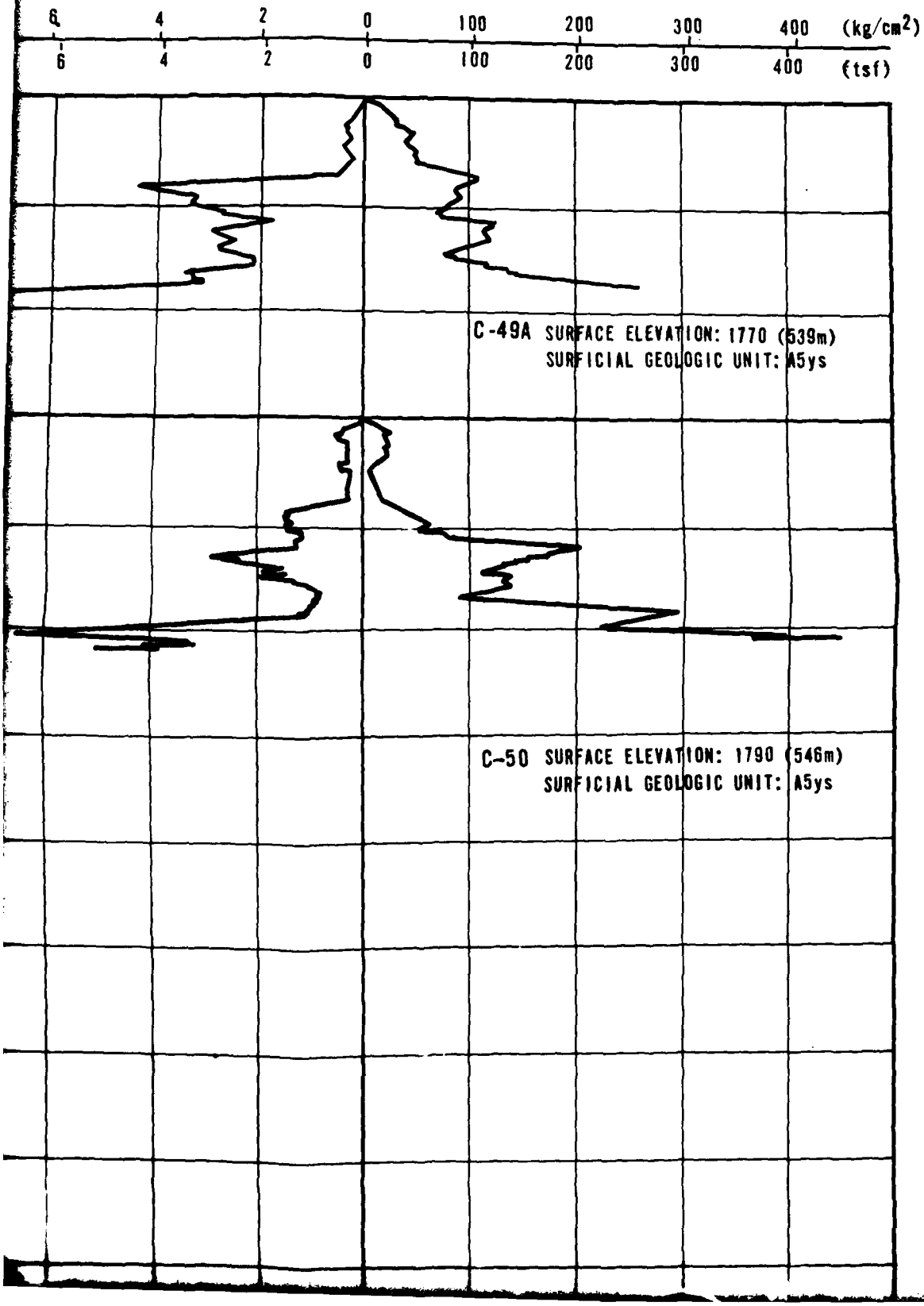
4 15

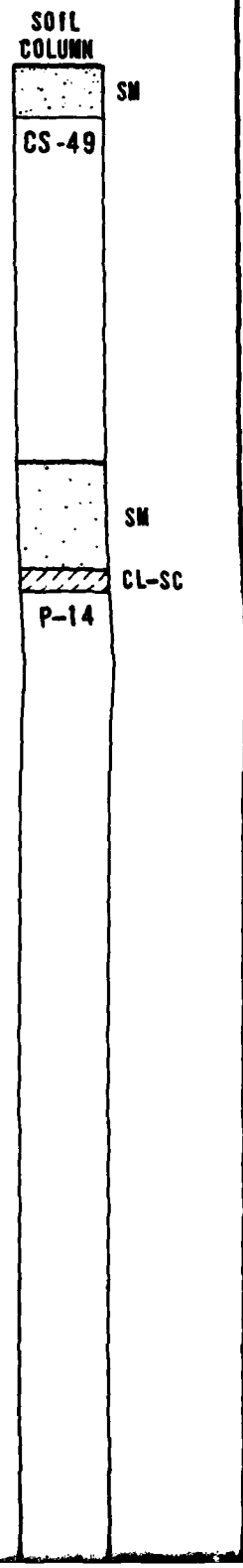


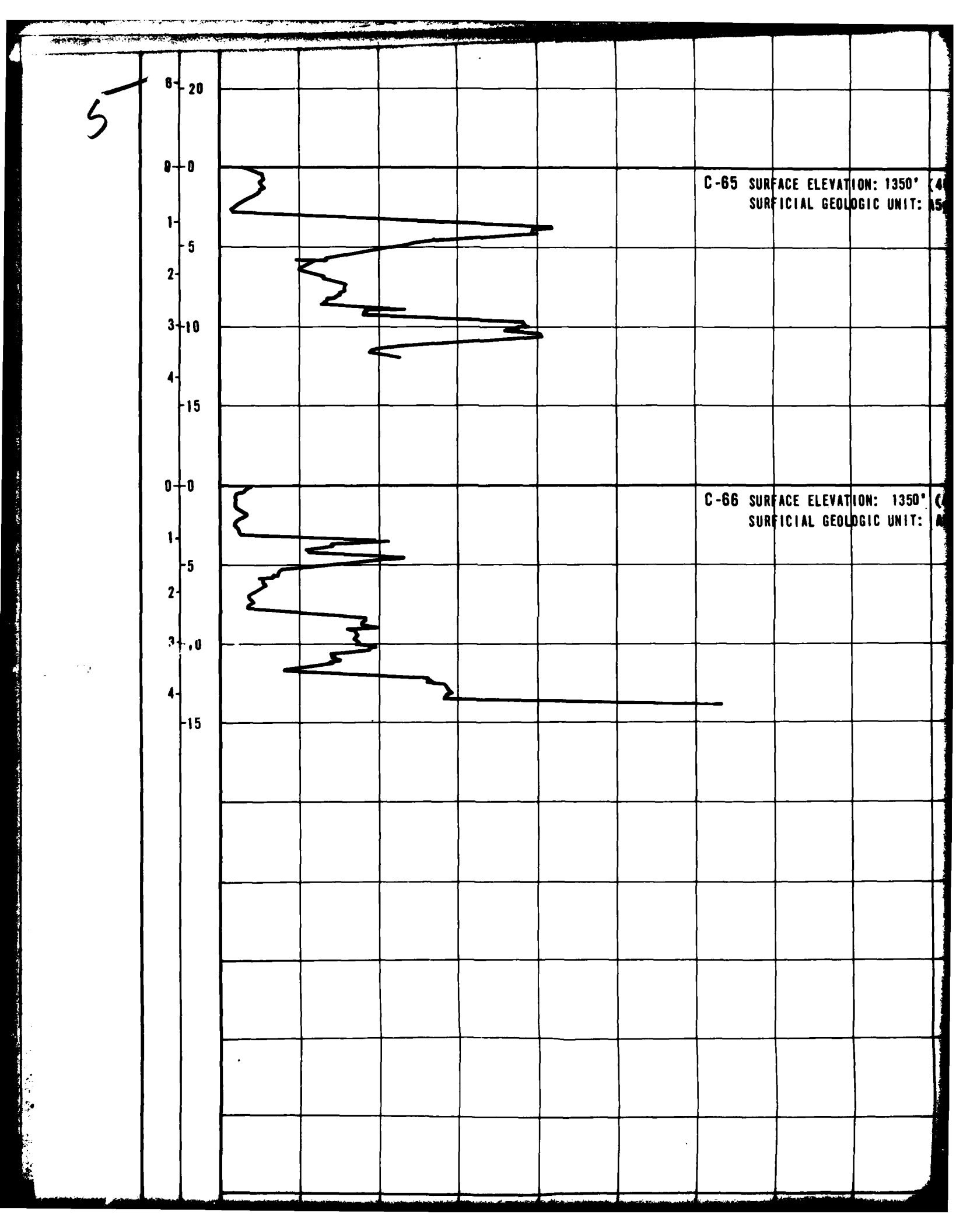
4

RICTION RESISTANCE

CONE RESISTANCE






5
6
20
0
0
1
5
2
3
10
4
15
0
0
1
5
2
3
0
4
15
C-65 SURFACE ELEVATION: 1350'
SURFICIAL GEOLOGIC UNIT:
C-66 SURFACE ELEVATION: 1350'
SURFICIAL GEOLOGIC UNIT:

6

CE ELEVATION: 1350' (411m)
CIAL GEOLOGIC UNIT: A5ys

SM

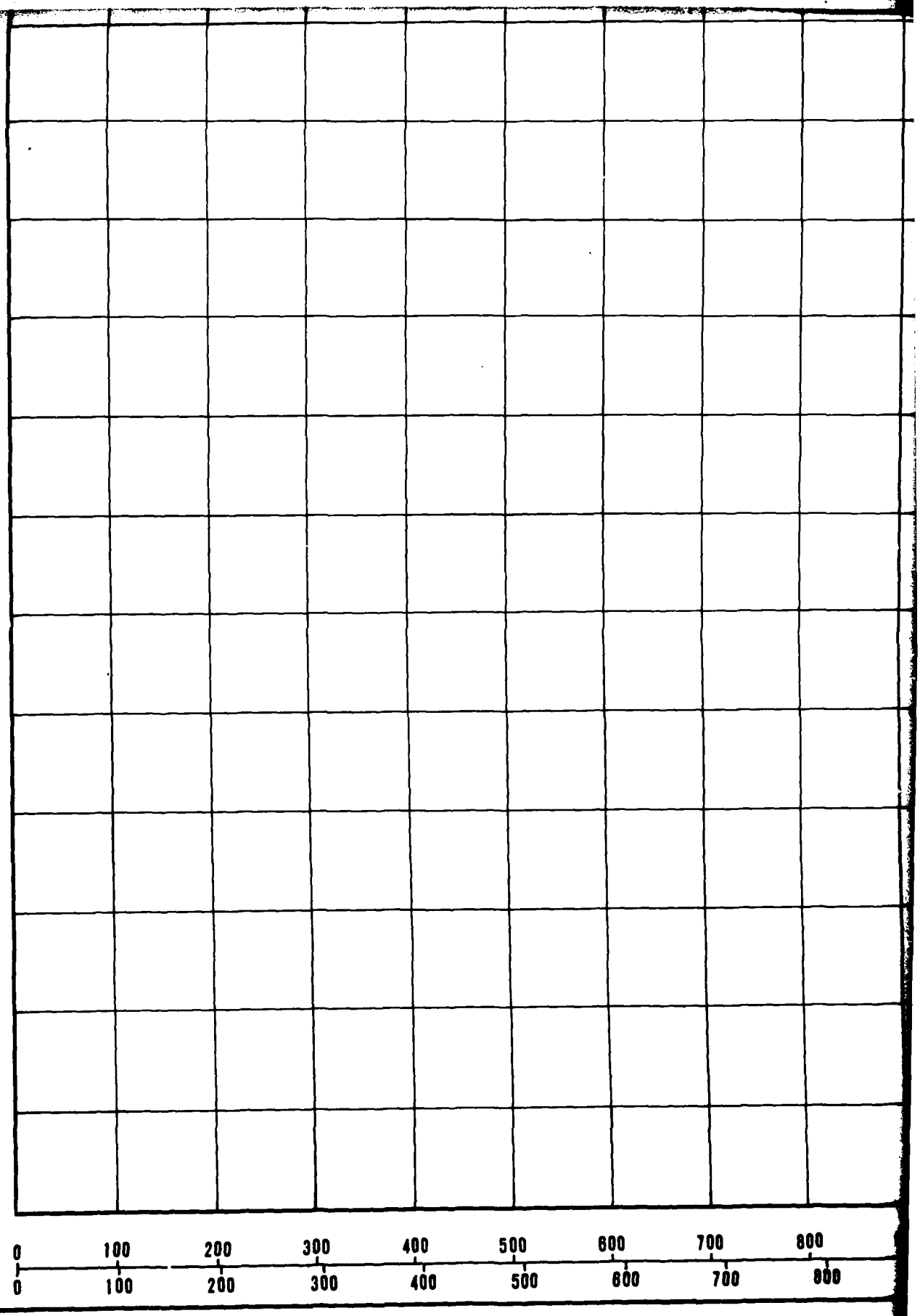
P-1

CE ELEVATION: 1350' (411m)
CIAL GEOLOGIC UNIT: A5ys

SM

CS-66

9



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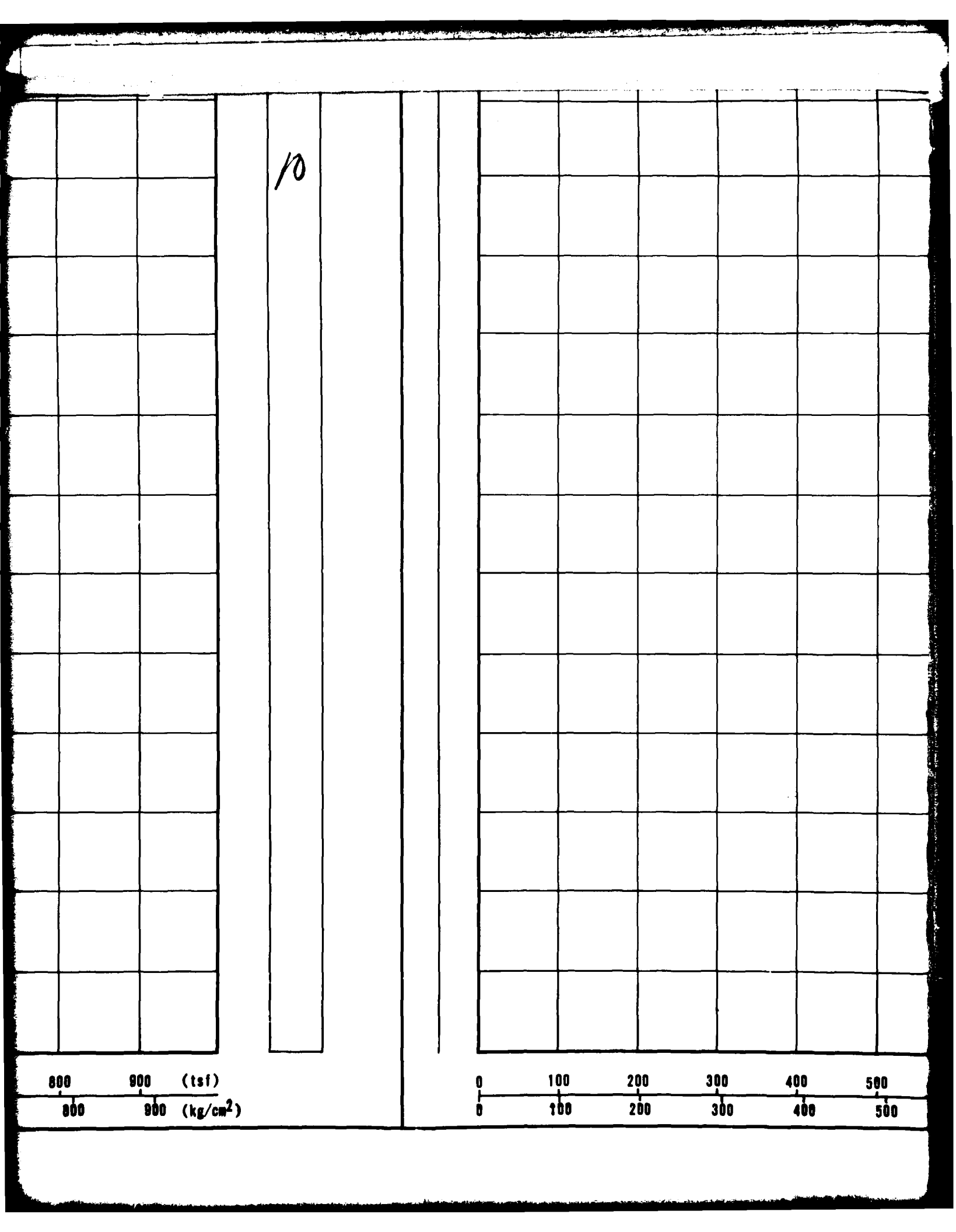
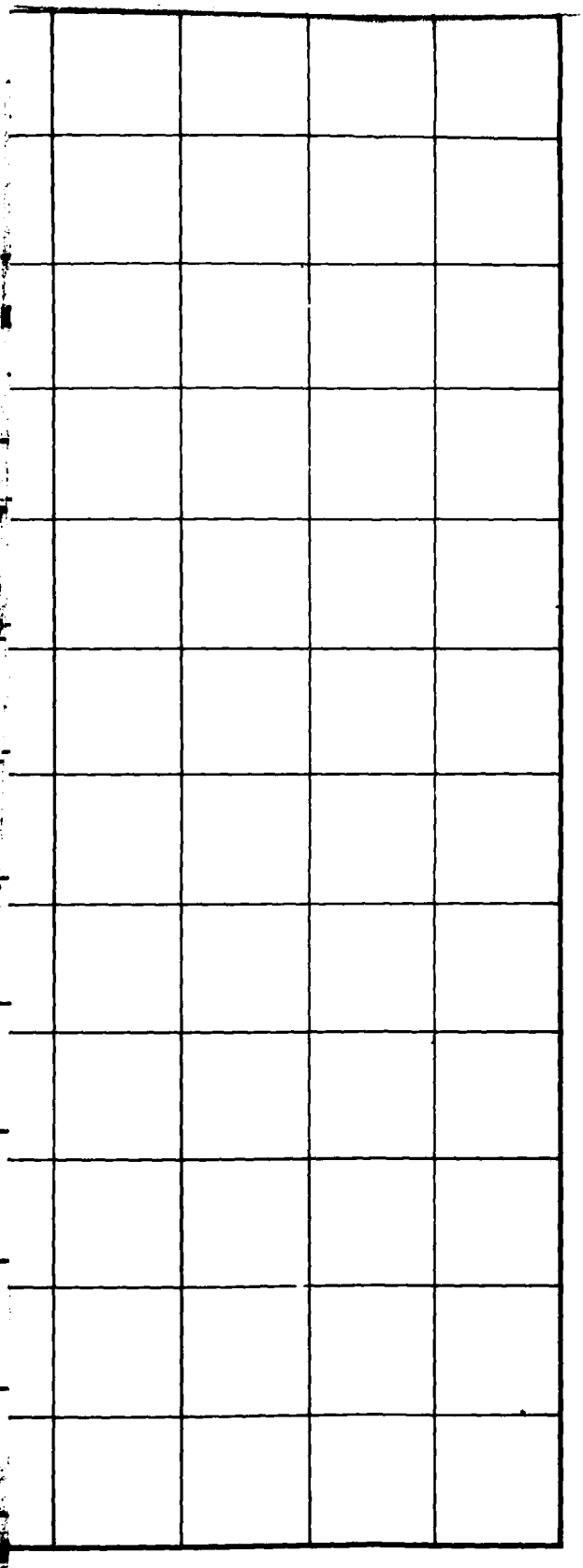
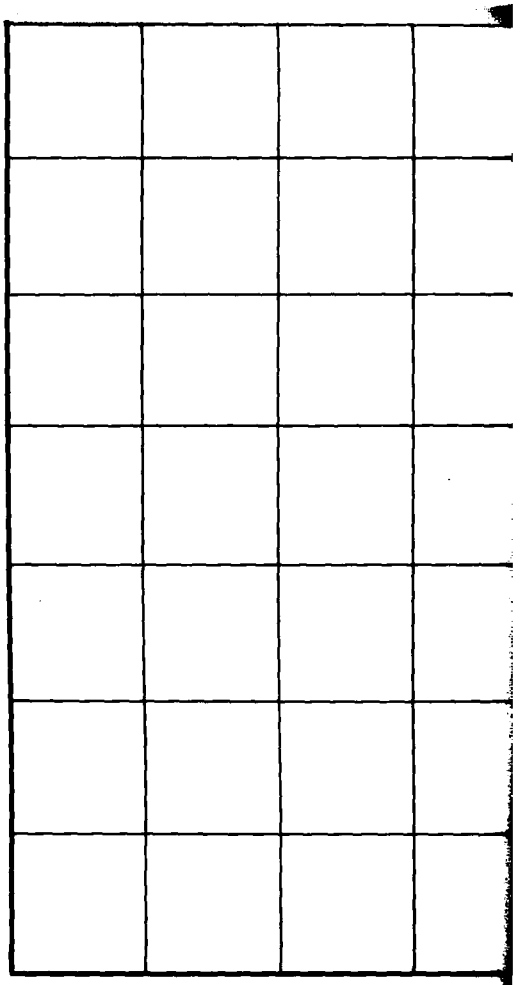
10 AUG 79


10
800
900
(tsf)
800
900
(kg/cm²)
0
100
200
300
400
500
0
100
200
300
400
500



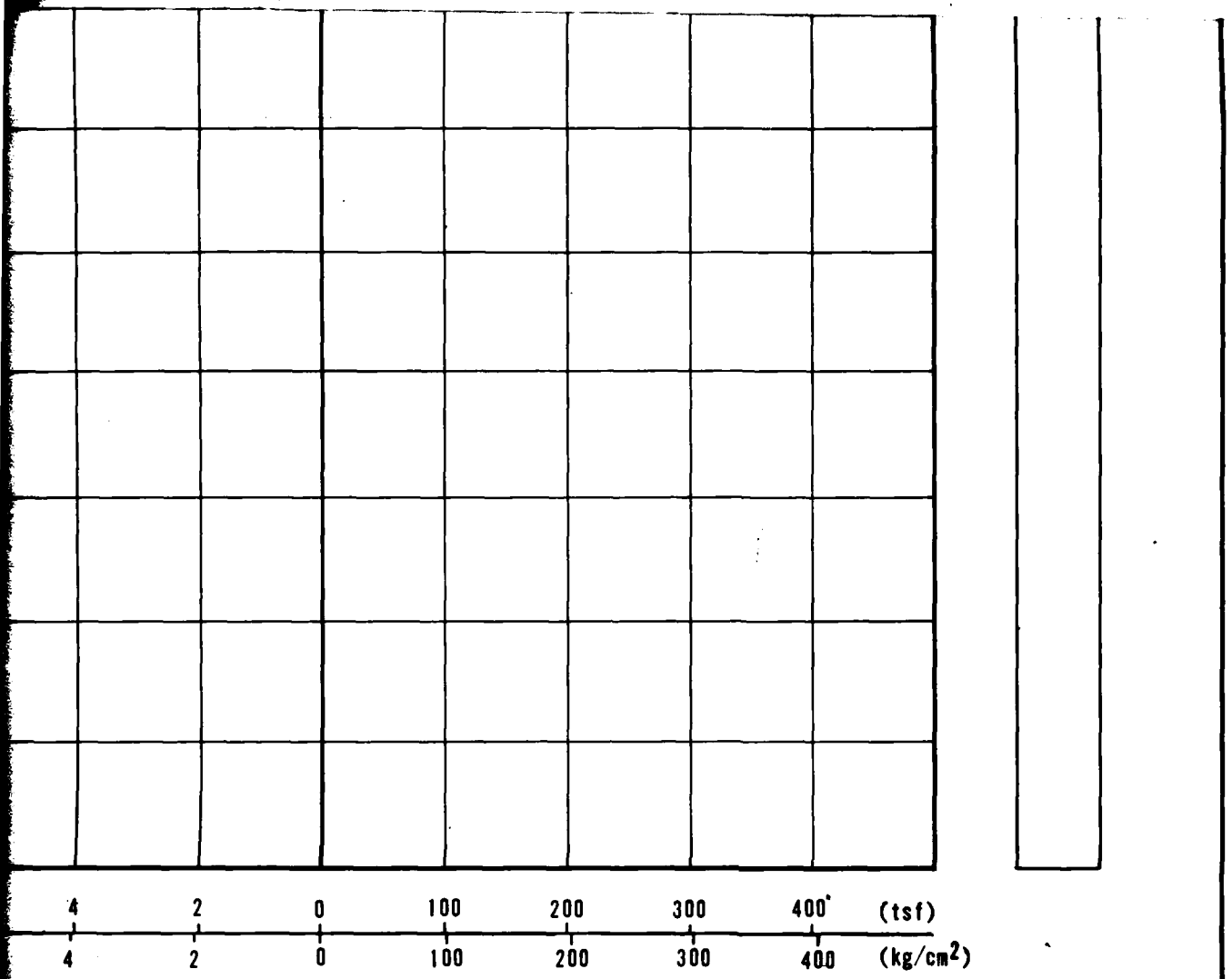
600 700 800 900 (tsf)

600 700 800 900 (kg/cm²)



10 8 6 4

10 8 6 4



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